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The potential impact of an auction based retention bonus and other factors on the continuation rates of general dentists completing their initial obligation

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THESIS

THE POTENTIAL IMPACT OF AN AUCTION BASED RETENTION BONUS AND OTHER FACTORS ON THE CONTINUATION RATES OF GENERAL DENTISTS COMPLETING THEIR INITIAL OBLIGATION

by

Robert L. Anderson

March 2007

Thesis Co-Advisors: William Gates
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This thesis seeks to determine the impact of an auction based retention bonus on continuation rates for general dentists completing their initial obligation. An auction based retention bonus has the potential to improve retention rates. In lieu of actual bids from Navy general dentists, the difference between average civilian dentist salaries and Navy general dentist pay is used to represent theoretical opportunity costs. Inputting opportunity costs into a break-even formula allows approximation of the retention bonus amount needed for a one-year and/or five-year employment agreement with the Navy.

A logistic regression retention model is also estimated using data for 516 Navy general dentists commissioned between 1998 and 2001. Model results indicate that accession source significantly affects the decision to continue military service. Officers commissioned as direct accessions and participants in the Dental Student Program are more likely to stay in the navy than participants in the Health Sciences Collegiate Program. Dentists commissioned in 2000-2001 are less likely to stay than those commissioned in 1998-1999. Those commissioned between the ages of 30 and 39 are more likely to continue service beyond their initial obligation than younger dentists. Race and gender do not significantly affect retention.

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ABSTRACT

This thesis seeks to determine the impact of an auction based retention bonus and other factors on the continuation rates for general dentists completing their initial obligation. An auction based retention bonus has the potential to improve retention rates. In lieu of actual bids from Navy general dentists, the difference between average civilian dentist salaries and Navy general dentist pay is used to represent theoretical opportunity costs. Inputting opportunity costs into a break-even formula allows approximation of the retention bonus amount needed for a one-year and/or a five-year employment agreement with the Navy.

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I. INTRODUCTION AND BACKGROUND

A. INTRODUCTION

The Bureau of Medicine and Surgery (BUMED) is Navy Medicine Headquarters.[1] Led by a three-star Admiral, Navy Medicine provides high quality, economical health care to beneficiaries in times of war and peace. All Medical Department Officers fall into one of four professional organizations: Medical Corps, Medical Service Corps, Nurse Corps, or Dental Corps.

Two of the greatest challenges facing these organizations are finding qualified candidates to become Medical Department Officers and keeping these highly trained personnel beyond their initial obligation. This is especially true for the Dental Corps (DC) where recruitment and retention have become critical issues. For example, since fiscal year 2003, the Dental Corps has not been able to meet its total annual accession goals.[2] In addition, a Commander Navy Personnel Quick Poll in 2005 found that Dental Officers reported they were less likely to continue in the Navy than in previous years.[3] Should these challenges go unmet; the DC will be hard pressed to continue meeting its operational and domestic missions.

1. Research Questions

- Identify the significant characteristics of general dentists who opt to stay and those of general dentists who choose to leave the Navy after completing their initial obligation.
- Identify the opportunity costs of general dentists to aid in determining a bonus level that sufficiently entices dentists to remain in military service.
- Identify potential behaviors (stay / leave) of general dentists given a retention bonus.

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[1] Bureau of Medicine and Surgery webpage http://navymedicine.med.navy.mil/default.cfm?selTab=bumed&ecmid=93E9008D-802E-D019-ABBA0925B2764081 (Last Accessed January 2007).

[2] CDR Richard Houser, MSC, USN, email to author 14 December 2006.

[3] Carol Newell, Kimberly Whittam, & Zannette Uriell, "CNP Quick Poll, Medical Communities: Dental Corps, Medical Corps, Medical Service Corps, and Nurse Corps," 6 June 2005.

2. Scope and Methodology

The goal of this paper is to determine the retention behaviors of general dentists facing their first decision to stay or leave the Navy, if retention bonuses were available. A regression model is estimated for general dentists to identify the characteristics and behaviors of dentists that lead them to continue beyond their initial obligation. This information is then used to indicate who might be interested in receiving a retention bonus. Next, the application of auction theory is used to suggest the response of general dentists who are eligible for a retention bonus, given their opportunity costs. Salary surveys that compare military and civilian wages are utilized to represent opportunity costs since pay is frequently cited as a reason for leaving.

B. BACKGROUND

1. History of the Navy Dental Corps

Congress officially established the Navy Dental Corps in 1912 with the appointment of "not more than 30 dental surgeons."[4] The contributions of these professionals were seen almost immediately as Navy dentists treated conditions that had previously kept many recruits from active duty eligibility.[5] During World War I, the Dental Corps expanded to over 500 dentists assigned to shore commands as well as deployable units, such as ships and the United States Marine Corps.[6] Today, Navy dentists continue the tradition of providing quality dentistry to the men and women in the United States Marine Corps and Navy.

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[4] Navy Department, Manual of the Medical Department, NAVMED P-117 (Washington, DC: 1996), Chapter 6, 3.

[5] "90 Years of Marching Forward." Dental Corps History at Naval Medicine Online Webpage http://navalmedicine.med.navy.mil/default.cfm?seltab=about&selmod=7AF79F11-2A5E-780B-45D6C0D83FF101C8&docid=10307&parentid=942CA57C-802E-D019-A46C463C916A02D3& (Last Accessed January 2007).

[6] Ibid.

2. Organization and Composition of the Navy Dental Corps

Headquartered in Washington, D.C. at the Bureau of Medicine and Surgery, the Navy Dental Corps is led by a Rear Admiral. He or she reports to the Chief of the Bureau of Medicine and Surgery, and is responsible for matters pertaining to the Dental Corps community, including accessions, promotions, training, formulation of policy, and oversight of the Department of the Navy Dental Healthcare System.[7]

The mission of the Dental Corps is to "ensure dental readiness while optimizing dental Health."[8] The DC's vision is to provide "dental health for those entrusted to our care."[9] To accomplish these goals, the corps follows these guiding principles:

- Proudly serve and are prepared to defend the country.
- Privileged to be entrusted with the dental health of Sailors and marines. Anything less than the best effort violates that trust.
- Foster pride, teamwork and professionalism by personally exemplifying the Navy Core Values: Honor, Courage, and Commitment.
- Committed to excellence in clinical dentistry through training, continuing education and research.
- Value the individual contribution of every Sailor, marine, and civilian. Nurturing their personal growth and dignity is imperative to mission accomplishment.
- Believe the future is dependent upon developing the best possible leaders at every level.
- Embrace Readiness-Optimization-Integration as the business focus.
- Believe patients and customers ultimately judge success.[10]

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[7] Navy Department, Manual of the Medical Department, NAVMED P-117 (Washington, DC:1996), Chapter 6, 5.

[8] Navy Medicine webpage http://navymedicine.med.navy.mil/default.cfm?seltab=bumed&ecmid=93E9008D-802E-D019-ABBA0925B2764081&docid=12015 (Last Accessed January 2007).

[9] Ibid.

[10] Ibid.

There are 1,116 dentists in the DC, representing 18 different specialties working towards the DC's mission and goal.[11] The majority of these specialists were originally recruited as general dentists, and then, after completing their initial obligation, afforded additional training in a dental specialty in exchange for continued service in the Navy. Therefore, when accession goals for general dentists are not met, the impact is felt in the manning of future specialty levels. In other words, if the Navy is unable to satisfy its immediate annual needs for generalists, this potentially affects the number of specialists to be trained in the future. Underlying this fact is that without meeting accession goals and siphoning generalists into specialty training programs ultimately means general dentists will continue to be undermanned. Table 1 illustrates these different specialties and their current manning status as of June 2006.

Table 1. DC Manning by Specialty as of June 30, 2006[12]

Specialty	Inventory	Billets Authorized	% Manned	Proj EOY % Manned
Military(General)Dentist	410	463	89	77[13]
Endodontist	47	47	100	88
Military Dentist II	121	90	134	120
Comprehensive Dentist	105	113	93	85
Maxillofacial Prosth	11	6	183	157
Orthodontist	20	16	125	112
Operative Dentist	18	22	75	67
Oral Diagnostician	10	14	82	57
Exodontist	42	19	221	200
Oral Surgeon	78	80	98	77
Periodontist	53	48	110	102

[11] This number reflects actual beginning strength in FY'06 as reported in "Dental Corps One Page World Book" by the Dental Corps Analyst, LCDR Roshard Woolfolk, MSC, USN, 15 July 2006.

[12] LCDR Roshard Woolfolk, MSC, USN, "Dental Corps July 2006 World Book." Data valid as of 30 June 2006.

[13] CAPT Donald Worm, DC, USN, General Dentist Specialty Leader reported the manning situation at 63% during a telephone conversation with author 22 December 2006.

Specialty	Inventory	Billets Authorized	% Manned	Proj EOY % Manned
Prosthodontist	49	65	75	72
Public Health Dentistry	9	7	113	113
Oral Pathology	9	9	100	100
Oral Facial Pain	14	10	127	118
Dental Research	2	6	29	43
Pediatric Dentist	17	14	106	81
Students	101	134	75	81

3. Accession Programs

As cited earlier, recruiting dentists and dental students has been a challenge for the Navy. These difficulties may be due to a military-civilian wage gap, an active-duty commitment during an unpopular war, the prospect of separation from family because of operational deployments and more. Yet, each year approximately 100 individuals join the Navy Dental Corps. Those wanting to become Navy dentists may take advantage of one of the multiple commissioning programs available.

Current accession programs include:[14]

- Direct Procurement. Recruiting an officer directly from a civilian environment.
- Recall to Active Duty. The voluntary return of a commissioned officer from the Reserve to active component.
- Interservice Transfer (IST). The transfer of a commissioned officer serving on active duty, between uniformed services; or the transfer of commissioned officers not on active duty, between the Reserve components of the uniformed services.
- Health Sciences Collegiate Program (HSCP). Two-year scholarship program in designated health professions to complete degree/certification requirements and obtain Reserve officer commission in the active duty component of the Dental Corps upon graduation. Participants are considered enlisted with full pay and benefits.

[14] Navy Department, Administration of Health Professions Accession Programs (HPAP), OPNAVINST 1110.1A (Washington, DC: February 2007), 2-3.

- Health Professions Scholarship Program (HPSP). HPSP is an Inactive Ready Reserve program for students accepted to or enrolled in an accredited training program leading to a health profession degree. HPSP provides full tuition scholarship for dental school and includes funding for required books, fees and equipment. Additionally, a monthly stipend is provided. This Inactive Ready Reserve program permits graduates of the HPSP to obtain graduate professional education in accredited civilian institutions.
- Financial Assistance Program (FAP). FAP is an Inactive Ready Reserve Program for physicians or dentists currently accepted to or enrolled in an accredited residency or fellowship program progressing toward a specialty that has been designated as critical to Department of Defense (DOD).
- Health Professions Loan Repayment Program (HPLRP). HPLRP is an active duty and Reserve program used to recruit qualified health professionals in specific specialties. Under the HPLRP, the Navy repays all or a portion of participant-incurred educational loan obligations.

Table 2 shows accessions for new dentists in four programs over the past four fiscal years.

Table 2. Dental Officers by Accession Program: Accessions Achieved as a Percent of Accession Goal[15]

	Fiscal Year			
Program	**2003 (%)**	**2004 (%)**	**2005 (%)**	**2006 (%)**
DA	13/31 (42)	10/25 (40)	9/15 (60)	5/15 (33)
HSCP	15/25 (60)	23/30 (77)	22/26 (85)	30/30 (100)
FAP	4/6 (67)	1/6 (17)	0/6 (0)	2/6 (33)
HPSP	80/80 (100)	97/98 (99)	69/85 (81)	57/57 (100)
TOTAL	112/142 (79)	131/159 (82)	100/132 (76)	94/126 (75)

Fiscal year 2006 represents the worst year of the four only with 75% of the total goal met. During this four- year time frame, HPSP brought in the largest number of dentists and had the most success in terms of reaching the largest percentage of its annual goals; conversely FAP was the least successful at bringing dentists into the Navy.

[15] CDR Richard Houser, MSC, USN, email to author 14 December 2006.

4. Military Pay

Military pay is congressionally approved, based on rank and years of service. Increases in pay occur based on promotions and years of service. Based on the military pay scale, a military service member may, therefore, expect an increase in pay every two years even without an increase in rank. Military compensation also includes allowances for housing (with and without dependents) and for subsistence.

Dentists are also eligible for various bonuses to alleviate the military-civilian wage gap. Depending on the officer's specialty, rank, years of service, and contractual commitment, thousands of dollars may be added to a dentist's annual income. A description of each of the specialty pays follows:

a. Variable Special Pay (VSP)

This bonus is available to those dental officers with at least one year of active duty service remaining, unless the officer falls under one of the exceptions outlined in Department of Defense Financial Management Regulations. No additional contractual obligation is needed to be eligible for this special pay. Table 3 shows the annual rates based on creditable years of service.

Table 3. Variable Special Pay[16]

VARIABLE SPECIAL PAY	
YEARS OF CREDITABLE SERVICE	**SPECIAL PAY AMOUNT ($$ / YEAR)**
Less than 3*	3,000
At least 3 but less than 6**	7,000
At least 6 but less than 8	7,000
At least 8 but less than 12	12,000
At least 12 but less than 14	10,000
At least 14 but less than 18	9,000
At least 18 or more	8,000
Above O-6	7,000

*If undergoing training **Not undergoing internship training

[16] Navy Department, "Fiscal Year 2007 Dental Officer Special Pay Plan," Bureau of Medicine and Surgery Special Pay Page, 2007, http://navymedicine.med.navy.mil/default.cfm?seltab=bumed&ecmid=93E9008D-802E-D019-ABBA0925B2764081&docid=10766 (Last Accessed 16 January 2007).

b. Additional Special Pay (ASP)

A dental officer not participating in an internship, fellowship or initial dental residency training, and possessing a current unrestricted license is eligible for ASP.[17] An officer must agree to remain on active duty for at least 12 months to receive this money.[18] Payments are disbursed monthly based on the years of creditable service and commence on the contract's execution date. Table 4 shows the annual rates for ASP.

Table 4. Additional Special Pay[19]

ADDITIONAL SPECIAL PAY	
YEARS OF CREDITABLE SERVICE	**SPECIAL PAY AMOUNT ($$ / YEAR)**
Less than 3	4,000
At least 3 but less than 10	6,000
At least 10 or more	15,000

c. Board Certification Pay (BCP)

A dental officer who is eligible for VSP and who holds a "current, valid, unrestricted license or approved waiver and is board certified, by a Navy recognized board, is entitled to BCP."[20] BCP is in addition to any other pay and allowances the officer is eligible to receive, and payment is based on years of creditable service. Table 5 shows the bonus levels for eligible dentists.

Table 5. Board Certified Pay[21]

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[17] Department of Defense, Financial Management Regulation Military Pay Policy and Procedures – Active Duty and Reserve Pay, DoDFMR 7000-14R, Volume 7A, Chapter 6 (Washington, DC: 2005) 7.

[18] Ibid.

[19] Navy Department, "Fiscal Year 2007 Dental Officer Special Pay Plan," Bureau of Medicine and Surgery Special Pay Page, 2007, http://navymedicine.med.navy.mil/default.cfm?seltab=bumed&ecmid=93E9008D-802E-D019-ABBA0925B2764081&docid=10766 (Last Accessed 16 January 2007).

[20] Ibid.

[21] Navy Department, "Fiscal Year 2007 Dental Officer Special Pay Plan," Bureau of Medicine and Surgery Special Pay Page, 2007, http://navymedicine.med.navy.mil/default.cfm?seltab=bumed&ecmid=93E9008D-802E-D019-ABBA0925B2764081&docid=10766 (16 January 2007).

Board Certified Pay	
Years of Creditable Service	**Pay Level ($)**
Less than 10	2,500
With at least 10 but less than 12	3,500
With at least 12 but less than 14	4,000
With at least 14 but less than 18	5,000
With at least 18 or more	6,000

d. Dental Officer Multiyear Retention Bonus (DOMRB)

Dental officers may receive the DOMRB for agreeing to extend their active duty obligation by two, three, or four years.[22] This bonus is directed towards the experienced clinical specialist and eligibility is targeted to a dental officer below the rank of O-7 who has a valid, unrestricted license with at least eight years of creditable service, or who has completed his/her active duty service commitment for dental education and training.[23] Payment is received annually on the anniversary date of the agreement.[24] Table 6 illustrates the payment schedule for DOMRB.

Table 6. Dental Officers Multiyear Retention Bonus[25]

Dental Officer Multiyear Retention Bonus (DOMRB) Rates			
Specialty	**2 Year Agreement ($$)**	**3 Year Agreement ($$)**	**4 Year Agreement ($$)**
Oral Maxillofacial Surgeons	25,000	38,000	50,000
Comprehensive/Operative Dentistry	20,000	30,000	40,000
Endodontics	20,000	30,000	40,000
Prosthodontics	20,000	30,000	40,000
Orthodontics	18,000	27,000	35,000
Oral Pathology/Oral Diagnosis/ Oral Medicine	18,000	27,000	35,000
Pediatric Dentistry	18,000	27,000	35,000

[22] Ibid.

[23] Ibid.

[24] Ibid.

[25] Navy Department, "Fiscal Year 2007 Dental Officer Special Pay Plan," Bureau of Medicine and Surgery Special Pay Page, 2007, http://navymedicine.med.navy.mil/default.cfm?seltab=bumed&ecmid=93E9008D-802E-D019-ABBA0925B2764081&docid=10766 (16 January 2007).

Dental Officer Multiyear Retention Bonus (DOMRB) Rates			
Specialty	**2 Year Agreement ($$)**	**3 Year Agreement ($$)**	**4 Year Agreement ($$)**
Public Health Dentistry	18,000	27,000	35,000
Temporomandibular Dysfunction (TMD)	18,000	27,000	35,000
Dental Research	18,000	27,000	35,000
Exodontia (Advanced Clinical Practice)	13,000	19,000	25,000
Endodontics (Advanced Clinical Practice)	13,000	19,000	25,000
General Dentistry [Comprehensive Dentistry] (Advanced Clinical Practice)	13,000	19,000	25,000
Periodontics (Advanced Clinical Practice)	13,000	19,000	25,000
Prosthodontics (Advanced Clinical Practice)	13,000	19,000	25,000

e. Critical Skills Retention Bonus

Designed to be an incentive to keep critically needed medical professionals in the service, the CSRB was authorized in the 2000 National Defense Act.[26] However, it was not funded until 2003. Those dentists, not in graduate professional education, choosing to extend their active duty obligation by 12 months were eligible to receive a one-time payment of $12,000.

5. Characteristics of New Dental School Graduates

The most recent ADA survey of dental graduates involves the graduating class of 2004. Not surprisingly, the demographics of class of 2004 are similar to those of the Navy general dentists evaluated in Chapter III, because there are so few years separating these groups of individuals. Table 7 compares the class of 2004 with Navy Dental Corps Officers commissioned in 1998-2001.

[26] Department of Defense, Financial Management Regulation Military Pay Policy and Procedures – Active Duty and Reserve Pay, DoDFMR 7000-14R, Volume 7A, Chapter 6 (Washington, DC: 2005) 12.

Table 7. 2004 Dental Graduates versus Navy General Dentists Commissioned 1998-2001[27]

Characteristic	2004 Dental Graduate	Navy General Dentist[28]
Age, average (years)	29.1	28.2
Age Range (years)	23 through 52	24 through 47
Over 30 years old (%)	20.7	20.9
Male to Female Ratio	59.1 : 40.9	72.5 : 27.5

Nearly 92 percent of the 2004 graduates responding to the survey left school with some level of education debt; a debt that on average tallied $131,200.[29] This debt load was the highest on record and represented a 27 percent increase over the class of 2000.[30] These figures suggest graduates will need to seek positions with compensation or benefit programs that can best resolve their indebtedness.

The ADA reported that of the 2004 graduates responding to the survey, more than 78 percent claimed general practice dentistry as their area of practice, research, or administration area. Nearly 20 (19.2) percent of all respondents are independent dentists who own their own or share ownership of a dental practice and over 68 percent are identified as non-owner dentists.[31] Almost 6 (5.8) percent of the graduates are employed with the armed forces.

[27] The American Dental Association, Survey Center, The 2005 Survey of Dental Graduates (Chicago, IL), September 2006, 18(4).

[28] BUMIS data.

[29] The American Dental Association, Survey Center, The 2005 Survey of Dental Graduates (Chicago, IL), September 2006, 16.

[30] Ibid.

[31] Ibid., 13.

6. Chapter Overview

This paper is organized into six sections to provide a logical description of the behaviors of general dentists as they decide to stay or leave the Navy. Chapter I provides background information on the Dental Corps; its history, composition, accession programs, military compensation and special pays. Chapter II provides a literature review of different studies of the retention of Navy medical and non-medical communities. It also includes a review of auction theory literature. Chapter III discusses the data and methodology used to analyze general dentists, retention behavior. Chapter IV defines the variables used in the analysis and reports the results of the regression. Chapter V describes a theoretical application of auction theory to general dentists at their initial decision to continue their military service. Chapter VI reports the findings of the regression outcomes and results of the experiment.

II. LITERATURE REVIEW

A. RETENTION STUDIES

The rising cost of healthcare is a major concern to Americans, and this concern is true for the military as well. Not surprisingly, the personnel costs for professional medical personnel are increasing too. Accession, training, and retention of these people are expensive activities, and medical skills are in high demand in the civilian workplace. Consequently, there exists much literature regarding their attrition, training, and retention.

The National Defense Authorization Act for Fiscal Year 2001 directed the Secretary of Defense to review and then report to Congress on the adequacy of the special pays and bonuses for medical corps officers and other health professionals.[32] Subsequently, The Center for Naval Analysis published the Health Professions' Retention-Accession Incentives Study Report to Congress. In this paper the authors noted that the Department of Defense's (DoD) military health system (MHS) has two missions. The first is to ensure medical capabilities are available to support combat operations and that uniformed members of the armed forces are healthy.[33] The second mission is to provide a "healthcare benefit" to more than 6 million other beneficiaries.[34] As such, it is an expensive process to access, train, and keep needed medical professionals to satisfy these missions. These challenges are compounded when there is a high demand for these professionals in the civilian work force as well.[35]

The purpose of the paper was to determine if uniformed healthcare professionals were being adequately compensated. The authors wrote, "We believe the answer lies in

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[32] Shayne Brannman, Michele Almendarez, Cori Rattelman, and Elaine Scherer, Health Professions' Retention-Accession Incentives Study Report to Congress (Phase 1: Compensation Comparison of Selected Uniformed and Private-Sector Health Care Professionals), Center for Naval Analysis, [Washington, D.C.: 2002] 1.

[33] Ibid.

[34] Ibid.

[35] Ibid.

the MHS' ability to fill both its peace time and active component readiness requirements with the right professionals, the right skill mix, and the right years of experience from today's force and future accessions."[36] If positions systematically went unfilled, or were not assigned to persons with the appropriate rank / experience, then special pays would need to be adjusted. To determine if military medical professions were adequately compensated, the authors had to answer several underlying questions, such as:[37]

- Has retention increased or decreased in the last ten year?
- Does an adequate inventory exist to meet both readiness and peace time roles?
- Does a balance exist between junior, middle, and senior personnel?
- How much does the civilian-military pay gap affect retention?

Based on information from DMDC and HMPDS, the authors described a significant force structure change in the MHS' Dental Corps between 1991 and 2000. Through downsizing, the number of military dentists was reduced 28 percent in ten years.[38] Of those reductions, the numbers of general dentists were cut by 38% in the DoD and by 40% in the Navy.[39] Furthermore, among general dentists there was an increase in the number of O-3 dentists but a significant reduction of O-4s.[40]

In terms of analyzing military dentist retention, the low number of O-4s in the inventory is not a surprise, given that dentists who opt to leave the Navy do so prior to the eighth year of service.[41] Typically, Navy DC Officers are eligible for promotion to Lieutenant Commander approximately in the fifth or sixth year of service. However, the authors noted that they "can not directly conclude that it is more difficult to retain dentists now than ten years ago because there is no consistent or systematic yearly change

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[36] Shayne Brannman, Michele Almendarez, Cori Rattelman, and Elaine Scherer, Health Professions' Retention-Accession Incentives Study Report to Congress (Phase 1: Compensation Comparison of Selected Uniformed and Private-Sector Health Care Professionals),Center for Naval Analysis, [Washington, D.C.: 2002] 2.

[37] Ibid., 3.

[38] Ibid., 114.

[39] Ibid.

[40] Ibid.

[41] Ibid., 121.

in the survival curves over the last decade."[42] Moreover, the dramatic downsizing experienced during these years complicates the analysis and distorts the conclusion.

Commenting that "retention rates should be created using initial obligated service data," the authors attempted to build a data set of newly accessed dentists.[43] However , the authors were unable to obtain accurate obligated service data from DMDC, because the field was frequently blank or had been over written with new data for a subsequent obligation (for example, promotion, pay contract, etc.). Consequently, the authors created a longitudinal data file that isolated new uniformed dental officer accessions in fiscal year 1992 through 2000, and assumed that if a dentist did not exist in the previous year's data, then that dentist was a new accession.[44] This procedure was done for both general dentists and specialists.

After examining fiscal year (FY) 1992-1996 cohorts, the authors discovered that gender does not influence retention in any significant manner.[45] Retention rates remained nearly equal across military services. Not surprisingly, the analysis showed that after three or more years in a specialty, specialists have higher retention rates than general dentists across all services.[46] Specialists with this level of experience have demonstrated a greater commitment to the military. Table 8 illustrates survival rates for dentists in the Military Health System up to the eighth year of service.

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[42] Shayne Brannman, Michele Almendarez, Cori Rattelman, and Elaine Scherer, Health Professions' Retention-Accession Incentives Study Report to Congress (Phase 1: Compensation Comparison of Selected Uniformed and Private-Sector Health Care Professionals),Center for Naval Analysis, [Washington, D.C.: 2002] 121.

[43] Ibid., 123.

[44] Ibid.

[45] Ibid., 124.

[46] Ibid., 126. Dental specialists are normally selected from the general dentist community, so these individuals have already completed their initial active duty obligation and specialty training.

Table 8. MHS Dental Corps Cohort Survival Rates (FY 1992 through 1996)[47]

MHS Dental Corps Cohort Survival Rates (%), FY 1992 – 1996								
General Dentists	**1 yr**	**2 yr**	**3 yr**	**4 yr**	**5 yr**	**6 yr**	**7 yr**	**8 yr**
Navy	96	95	73	51	43	36	33	31
Army	94	89	61	53	47	43	39	36
Air Force	99	96	64	47	42	39	34	28

Table 8 shows a significant decrease in dentists beginning in year three. The Navy only retains 73 percent of its dentists by the third year of service. Perhaps more striking is that by the next year (year four), the survival rate for military dentists is 51 percent. Table 9 illustrates the aggregate MHS Dental Corps cohort four year survival rates by specialty.

Table 9. Aggregate MHS Dental Corps Cohort Four-Year Survival Rates (%) by Specialty (FY 1992-1996)[48]

Aggregate MHS Dental Corps Cohort Four-Year Survival Rates (%) by Specialty (FY 1992-1996(								
	Percent Surviving After							
General Dentists	**1 yr**	**2 yr**	**3 yr**	**4 yr**	**5 yr**	**6 yr**	**7 yr**	**8 yr**
1992	98	95	66	54	43	43	38	35
1993	98	96	64	54	46	39	36	
1994	92	92	70	53	44	39		
1995	97	96	74	55	48			
1996	95	92	63	39				

Approximately 30 percent of the general dentists leave military service at year three and nearly 50 percent leave after four years of service. However, across cohorts there is little variability in the survival rates which makes predicting retention improvements challenging.

The authors also examined the effect of pay on retention. The American Dental Association (ADA) income survey reported the average net income for general dentists

[47] Shayne Brannman, Michele Almendarez, Cori Rattelman, and Elaine Scherer, Health Professions' Retention-Accession Incentives Study Report to Congress (Phase 1: Compensation Comparison of Selected Uniformed and Private-Sector Health Care Professionals),Center for Naval Analysis, [Washington, D.C.: 2002] 125.

[48] Ibid., 127. For the purpose of this paper, only the results regarding general dentists were illustrated.

for 1992 through 1998. Based on this information, the authors concluded a "significant reduction in pay parity" existed between uniformed military dentists and civilian dentists.[49] To compare military and civilian wages, the authors estimated the maximum potential pay uniformed dentists could receive given characteristics such as grade, specialty, and years of service.[50] Only cash compensation was considered with military pay defined as regular military compensation (RMC), statutory compensation and discretionary pay.[51] Table 10 shows the MHS and civilian dentists' earning ratios.

Table 10. MHS and Civilian Dentists Earning Ratios by Years of Commissioned Service[52]

MHS and Civilian General Dentists Earning Ratios by YOCS						
Fiscal Year	**5**	**10**	**15**	**20**	**25**	**Avg**
1991	.55	.64	.74	.85	.92	.55
1992	.53	.62	.72	.82	.90	.54
1993	.49	.58	.67	.77	.85	.52
1994	.46	.54	.63	.71	.80	.49
1995	.45	.53	.62	.70	.78	.46
1996	.46	.54	.62	.70	.78	.48
1997	.47	.53	.59	.67	.75	.48
1998	.43	.54	.63	.69	.75	.47

[49] Shayne Brannman, Michele Almendarez, Cori Rattelman, and Elaine Scherer, Health Professions' Retention-Accession Incentives Study Report to Congress (Phase 1: Compensation Comparison of Selected Uniformed and Private-Sector Health Care Professionals),Center for Naval Analysis, [Washington, D.C.: 2002] 128.

[50] Ibid., 131.

[51] Ibid.

[52] Ibid., 133. For the purpose of this paper only general dentist information was illustrated from the original text.

MHS and Civilian General Dentists Earning Ratios by YOCS						
Fiscal Year	**5**	**10**	**15**	**20**	**25**	**Avg**
1999	.41	.53	.59	.68	.75	.44
2000	.41	.54	.62	.67	.80	.45
Pay Gap ($1,000s)	70.2	57.9	46.9	27.5	27.5	69.2

Table 10 suggests that military dentists are paid significantly less than their civilian counterparts, and the greatest disparity is at the junior dentist level.

Using more survival analysis techniques, the authors estimated the attrition rate for general dentists. The regression analysis controlled for several variables that could be correlated with attrition, such as gender, service, rank, years remaining until retirement, and if currently enrolled in a training program.[53] They did not control for accession source because DMDC data had changed over time and the quality of the accession source data was questionable.

Based on their analysis, the authors reported that "a $10,000 increase in compensation leads to a 7.2 percentage increase in the attrition rate."[54] In other words, if the dental corps experienced a 10 percent attrition rate for its general dentists, a $10,000 reduction in the pay gap would reduce the attrition rate to only 9.3 percent. Therefore, the authors concluded that a $10,000 increase in compensation has minimal effect on retention.[55] The authors offer a caveat for this conclusion by noting that this conclusion is based on aggregate data which may be affected by the inclusion of those nearing retirement, and these individuals made the decision to stay in the military many years ago. Although the analysis does not show a significant movement in the attrition rate for

[53] Shayne Brannman, Michele Almendarez, Cori Rattelman, and Elaine Scherer, Health Professions' Retention-Accession Incentives Study Report to Congress (Phase 1: Compensation Comparison of Selected Uniformed and Private-Sector Health Care Professionals),Center for Naval Analysis, [Washington, D.C.: 2002] 136.

[54] Ibid.

[55] Ibid.

all the dental corps with a $10,000 pay increase, it does suggest that a decrease in the pay gap does have a positive effect on attrition.[56]

Given this analysis of military compensation, the authors sought to determine if the dental corps could fill its peace time billets and readiness requirements with the proper skill mix and years of experience. Comparing manning levels between 1993 and 2003, the authors determined Navy dental manning rose to 99 percent from 94 percent over this period of time.[57] After looking at readiness requirements, the authors concluded that the services would meet their readiness requirements for the near future.[58]

Besides satisfying billet and readiness requirements, the services must have the proper number of dentists with the appropriate levels of experience. The services were asked to supply the ideal force structure. Only the Air Force supplied their version. Using the Air Force model, the authors concluded that that a "trough" exists in the dental corps; meaning that military dentists are either "very junior or very senior."[59]

In conclusion, the authors determined that military compensation may not be adequate because of the significant shortage of O-4s (mid-career dentists) in the MHS. This suggests that the current compensation levels / strategies do not provide sufficient incentives to retain an adequate number of dentists beyond their initial active duty obligation.[60]

In another study, Alan Christian sought to determine the critical factors influencing retention of junior Navy Dentists after completing their initial obligation.[61] Using data supplied from the BUMED Manpower Information System (BUMIS), Christian analyzed dental officers who started in or continued through 1994 and had at

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[56] Shayne Brannman, Michele Almendarez, Cori Rattelman, and Elaine Scherer, Health Professions' Retention-Accession Incentives Study Report to Congress (Phase 1: Compensation Comparison of Selected Uniformed and Private-Sector Health Care Professionals),Center for Naval Analysis, [Washington, D.C.: 2002] 136.

[57] Ibid., 140.

[58] Ibid., 141.

[59] Ibid., 143.

[60] Ibid., 144-145.

[61] Alan B Christian, Influences on the Retention of Residency-Trained and Non-Residency Trained Navy Dental Corps Officers, Naval Postgraduate School, [Monterey, CA.: 2004] 1.

least one record at the rank of Lieutenant.[62] Random samples were drawn from officers who were assigned to two cohorts; residency trained and non-residency trained.[63] Each sample group consisted of 100 individuals who served on active duty between 1994 through 2003.

Christian reported on the demographics of the Dental Corps. Male officers represented 91.2 percent of the total sample and nearly 79 percent of all dentists were Caucasian.[64] More dentists were Lieutenants (38.1 percent) than any other grade, followed by Commanders (25.5 percent).[65] Eighty-seven (43.5 percent) of the 200 sampled officers were accessed through direct procurement.[66] Of these dentists, more than 58 percent received some residency training while on active duty and 71 percent stayed in the Navy more than one year beyond their obligated commitment.[67]

Christian utilized nine independent variables in his logistic regressions. They were gender, commission source, subspecialty, operational tours, tours outside the continental United States, age when first paid as a dentist, number of years before residency, and ethnicity.[68] Christian learned from the results of the non-residency sample that female dental officers were more likely to leave the military upon completion of their obligated service, and that 100 percent of recall officers and 73.1 percent of dental students remained on active duty more than 12 months beyond their commitment.[69] Conversely, nearly 80 percent of Armed Forces Health Professions Scholarship Program

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[62] Alan B. Christian, Influences on the Retention of Residency-Trained and Non-Residency Trained Navy Dental Corps Officers, Naval Postgraduate School, [Monterey, CA.: 2004] 16.

[63] Ibid.

[64] Ibid., 23.

[65] Ibid.

[66] Ibid., 25.

[67] Ibid.

[68] Ibid., 26.

[69] Ibid., 27.

(HPSP) recipients left the service within one year of their commitment.[70] Of the 79 general dentists, only 36 (45.6 percent) opted to extend past their required obligated service.[71]

Interestingly, in terms of racial identity, Christian discovered that 75 percent of the officers classified themselves as not belonging to any specific ethnic group. Whether the DC Officers did not wish to provide that information or could not relate to the ethnic choices is undeterminable. However, the regression results showed that 52 percent of those officers stayed more than one year beyond their obligation.[72]

The results from the regression on the residency sample were somewhat different than the non-residency sample. Although females were more likely to exit military service, nearly 73 percent of direct accessions and 75 percent of AFHPSP accessed dentists continued their military service after completing their obligatory commitment.[73] Table 11 illustrates the statistically significant variables in Christian's model.

Table 11. Statistically Significant Variables[74]

Statistically Significant Variables		
Variable	**Non Residency**	**Residency**
Gender	X	X
Age when first paid as dentist		X
Commission Source	X	
Ethnicity		
Operational Tours	X	
Yrs before Residency		X

[70] Ibid.

[71] Alan B. Christian, Influences on the Retention of Residency-Trained and Non-Residency Trained Navy Dental Corps Officers, Naval Postgraduate School, [Monterey, CA.: 2004] 29.

[72] Ibid., 32.

[73] Ibid., 30.

[74] Ibid., 53-55.

Based on his findings, Christian recommended recruiting more trained dentists and offering more training opportunities for general dentists earlier in their career to address some of the retention issues. Furthermore, he suggested that dentists in their obligation period should be assigned operational tours "only when necessary."[75]

As CNA and Christian in their research have shown, retention is currently a challenge for the Dental Corps. If unable to retain the appropriate number of dentists, the DC will need to seek other methods to provide oral care to DoD beneficiaries. Work done by Richard Stacey suggests that contracting clinical dental specialists for the Dental Corps, instead of "growing them" via uniformed general dentists would be cost beneficial. The motivation for his research was the rising costs of recruitment and training compounded by the Navy's inability to meet accession goals. After examining the major costs involved in recruiting, accessing, training, and retaining general dentists to be specialists, Stacey's cost-benefit analysis model predicted a savings greater than $200,000 over a 10-year period in the Navy.[76] Based on his findings, Stacey recommended contracting civilian endodontists for "non-essential billets at all CONUS shore-based medical treatment facilities (MTFs), and increasing bonuses and specialty pays.[77]

Outside of the dental community, but still within the Navy medical department, Michael Bristol conducted a multivariate analysis on medical officers to determine if OPTEMPO has a significant effect on their retention behavior. The Navy Medical Corps faces some of the same accession, training, and retention issues faced by the Dental Corps. As Bristol explains, "Given the extensive investment in human capital in a resource constrained setting, the Navy can ill-afford for retention to persistently be lower than planned levels."[78] Bristol continues to describe why the manning levels for

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[75] Alan B. Christian, Influences on the Retention of Residency-Trained and Non-Residency Trained Navy Dental Corps Officers, Naval Postgraduate School, [Monterey, CA.: 2004] 56.

[76] Richard C. Stacey, Navy Dental Corps Contract or Uniform: Study of Factors Influencing Business Case Analyses, Naval Postgraduate School, [Monterey, CA.: 2006] 63.

[77] Ibid., 68.

[78] Raymond Bristol, Effect of Increased Operational Tempo (post 9/11) on the Retention of Navy Medical Corps Officers, Naval Postgraduate School [Monterey, CA.: 2006] 8.

physicians have been suffering, "The principal impediment to date, has been the disparity between military compensation and comparable civilian earnings, the civilian-military pay gap."[79]

Using demographic and military experience variables, Bristol developed difference-in-difference models to analyze the decisions of general medical officers and medical specialists prior to and after the events of September 11, 2001. Bristol discovered that years of service, years of service squared, race, being a single parent, being a flight surgeon or Undersea Medicine Physician, and OPTEMPO are significant factors for a General Medical Officer (GMO) in his or her decision to stay or leave. Gender, marital/dependency, and deployments were not significant factors.[80]

Not surprisingly, the general medical officer results were somewhat different than those of the specialists. The data suggested that the following significant factors in the retention decision for specialty trained physicians were different than GMOs: deployments, surgical specialties, occupational specialties, assigned to Naval Medical Center San Diego.[81] The common factors were years of service, years of service squared, deployments, and deployments post fiscal year 2002.[82]

Bristol concluded from his logistic regression models that deployments do not significantly affect GMO retention decisions. However, specialists are more likely to discontinue military service with increased deployments. Bristol's GMO results changed when he utilized a difference in difference model, then, the output showed GMOs who deploy are "considerably less likely to continue military service"[83] if they were deployed after 2002. The same held true for specialists.

The reviewed literature acknowledges that the retention of military Medical Department Officers, including Dental Corps officers, is a concern for the Navy. The

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[79] Raymond Bristol, Effect of Increased Operational Tempo (post 9/11) on the Retention of Navy Medical Corps Officers, Naval Postgraduate School [Monterey, CA.: 2006] 8.

[80] Ibid., 63-65.

[81] Ibid., 71.

[82] Ibid.

[83] Ibid., 82.

literature has attempted to describe the retention behaviors of professionals who face disincentives to stay in the military and strong incentives to join the civilian work force. The next section provides the background and conceptual foundation underlying auction theory; a tool that may be useful in countering the attraction of civilian employment.

B. AUCTION THEORY CONCEPTS AND LITERATURE

1. Defining Auction

Auctions are not new to the business world. Companies such as Sotheby's and Christies are world renown for their auctions of high end commodities. However, with the advent of the internet and eBay, auctions have become an activity in which everyone can participate provided one has access to the world wide web. McAfee and McMillan define an auction as "a market institution with an explicit set of rules determining resource allocation and prices on the basis of bids from the market participants."[84] In simpler terms, an auction has the potential to set an appropriate price for a good or service when the price of that commodity is unknown.[85]

2. Standard Types of Auctions

There are four basic types of auctions; the ascending bid, the descending bid, the first-price sealed bid and the second-price sealed bid.[86] The ascending bid is commonly called the English, or forward, auction, whereas the descending bid is also known as the Dutch auction. These auctions can also be organized as forward auction, with many buyers and one seller, or reverse auctions, with many sellers and one buyer. To prevent confusion, from this point on, this paper shall utilize the more common names for these types of auctions.

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[84] R. Preston McAfee and John McMillan, "Auctions and Bidding," *Journal of Economic Literature* XXV (Summer 1987), 701.

[85] William Gates, "Innovations in Special Pay and Bonuses," Presentation, 30 June 2006.

[86] Paul Klemperer, "Auction Theory: A Guide to the Literature," *Journal of Economic Surveys* 13, no. 3 (Summer 1999), 229.

a. English Auctions

English auctions are perhaps the most familiar type of auctions in the United States. There is a single seller with multiple bidders, and the price is gradually increased based on input from bidders. Bidders drop out of the auction as the price increases beyond what they desire to pay for the good. The highest bidder wins the object or service.

b. Dutch Auctions

Dutch auctions operate the opposite of English auctions. In this circumstance, there is still a single seller with multiple buyers. An auctioneer (buyer) begins with a high price and lowers the price until a bidder (buyer) accepts.

c. First-Price Sealed Bid Auctions

First-price sealed bids auctions involve independent bids without the knowledge of how others are bidding. Bids are kept secret until the winner is announced. The winner pays the amount he or she bid.

d. Second-Price Sealed Bid Auctions

Second-price sealed bid auctions are also called "Vickrey" auctions. They operate in the same manner as first price sealed bid auctions, except the winning bidder pays the second highest bid, or second price.

3. Auction Format Factors

Auctions are held with different objectives. The goal sought by a seller, for example to maximize profits, welfare, or even social efficiency, may help determine the type of auction needed to achieve that goal. However, there are seven other factors that need to be considered; revenue equivalence, risk tolerance among bidders, collusion,

reserve prices, private information, and the number of bidders. [87] These factors have all been discussed elsewhere for a similar context; only revenue equivalence will be discussed here.

a. Revenue Equivalence Theorem

Donald Campbell defined revenue equivalence theory as, given that "each of the n agents is risk neutral and each has a privately known value independently drawn from a common probability distribution, then all standard auctions have the bidders making the same expected payments at equilibrium, given their respective values, and the seller's expected revenue is the same for all standard auctions."[88] Basically, the theorem states that utilizing any of the four common auction formats will, on average, result in the same amount of profit provided the following conditions exist; bidders are risk neutral; bidders independently concluded the value of the good; the bidders are symmetric (values are drawn from similar probability distributions); and payment is a function of bids alone.

These four conditions, or assumptions, are also referred to as the *Benchmark Model*.[89] To relax any of these four conditions means that the four auction formats will not provide the same level of profits. Therefore, depending on the seller's objective, s/he would need to select an auction that would maximize that particular goal. This research assumes that the Benchmark Model holds, so auction design is not discussed in detail. However, this research will indicate the implications of violating the Benchmark Model assumptions.

4. An Application of Military Bonuses and Auction Theory

William Filip analyzed the manner in which Navy bonuses are distributed, and he recommended changes to the bonus program structure that could improve recruitment

[87] Henning H. Homb, Salary Auctions and Matching as Incentives for Recruiting to Positions that Are Hard to Fill in the Norwegian Armed Forces, Naval Postgraduate School [Monterey, CA.; 2006] 26.

[88] Donald E. Campbell, Incentives: Motivation and the Economics of Information, Cambridge University Press, [New York, NY.; 2006] 359.

[89] McAfee and McMillan, *Auctions and Bidding*, 706-707.

and retention.[90] His primary research goal was to identify a bonus structure that would sufficiently supply quality Naval Officers to meet recruitment and retention goals. Simultaneously, he wanted his format to be cost effective and so flexible that the Navy could compete with civilian labor market forces. Translated into simpler terms, during periods when the economy is strong and civilian wages are high, the Navy should expect to pay a higher bonus to keep its already trained personnel. Conversely, when the economy is weak and wages are lower, than a bonus may not even be needed.

Filip reviewed several targeted bonuses for the aviation, submarine, and surface warfare communities. He noted that each respective program was designed to either recruit people into needed areas or retain those already trained and who are in high demand by the civilian labor market.

Filip noted that the Navy uses signaling theory to identify the potential success of an individual officer. Some examples of signaling are the officer's fitness reports (fitreps) and "attainment of key promotion points" such as the completion of Joint Professional Military Education and /or achieving community qualifications.[91] An individual with solid fitreps and who obtains professional qualifications suggests, or signals, to Navy leadership s/he may be someone committed to staying in military service.

Filip's designed bonus structure permits officers to signal their stay/leave intentions by offering different obligation length contracts to the service.[92] Officers determine the bonus amounts for each respective contract by participating in a reverse, second-price auction. One of the benefits of such a structure is that "the signaling aspect of the program provides the Navy with insight into personnel manning trends, while

[90] William N. Filip, Improving the Navy's Officer Bonus Program Effectiveness, Naval Postgraduate School [Monterey, CA.; 2006] 36.

[91] Ibid.

[92] Ibid., 39.

allowing individuals to express their preference financially."[93] With an auction-based bonus format, competition and honest bidding are ensured while bonus levels mirror the overall economy and job market situation.

Filip's bonus program allows for two contract lengths. The contract with the longer duration offers a set bonus amount based on a winning bid. The shorter contract is for one-year and is designed to capture those officers who are uncertain about their long term commitment to the service. In a given year, the one-year contract may pay more than the longer contract, but a one-year bonus may not be available the following year. This flexibility allows the Navy the opportunity to achieve force shaping and to match the forces in effect in the civilian market.

Those officers with lower opportunity costs will agree to a longer contract with a lower level bonus. Officers with high opportunity costs may agree to a one-year contract with a high level bonus, and assume the risk that a bonus with a short term obligation might not be available the following year.

Figure 1 is an illustration of Filip's bonus format, offering two bonuses. One bonus is worth $15,000 per year contingent on a seven-year commitment. The second bonus is worth $25,000 in exchange for only one additional year of service. Filip mathematically demonstrates that not all officers will chose the short term contract. For this paper's purpose, suffice it to say that not everyone will select the higher bonus, because it comes with more risk. For example, because of the program's flexible design, the following year may see the one-year commitment bonus fall below $15,000, which is the bonus level for the seven-year commitment.

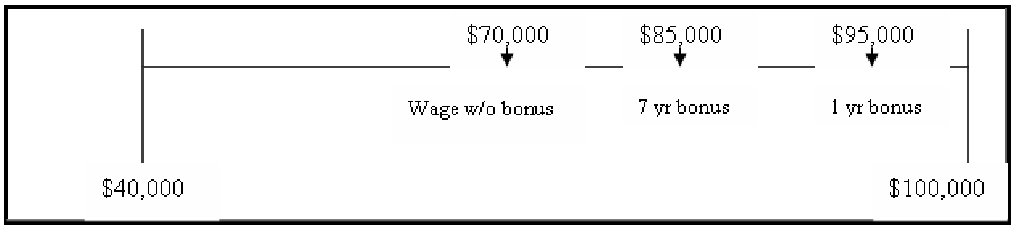

Figure 1. An Example of Filip's Bonus Format[94]

[93] Ibid.

III. DATA SOURCES, GENERAL METHODOLOGY, PRELIMINARY DATA, AND ANALYTICAL METHOD

A. DATA SOURCES

1. Bureau of Medicine Information System (BUMIS)

BUMIS is the information system utilized by BUMED to collect and maintain general, demographic, and professional information about its Medical Officers.[95] The original data set obtained for this study contained annual inventory files of all dentists from 1984 through 2005. Additionally, each respective year had a loss file, listing those dentists who were released from active duty service.

This research analyzes only general dentists commissioned between 1998 and 2001. All specialists and general dentists commissioned before 1998 and after 2002 were deleted from the data set. Eight dentists categorized as *Recalled* were also eliminated from the analysis since they had opted not to be on active duty full time. Two additional dentists accessed through the Financial Assistance Program were taken out of the study as well. From the remaining general dentists, two cohorts were created based on commissioning year. Each cohort represented two years of newly active commissioned Dental Corps Officers. The data elements utilized for this research include age (at time of commissioning), gender, race, and accession source.

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[94] William N. Filip, Improving the Navy's Officer Bonus Program Effectiveness, Naval Postgraduate School [Monterey, CA.; 2006] 42.

[95] Data provided by the Dental Corps Personnel Plans Analyst working in the Navy Medicine, Manpower, Personnel, Training & Education Command Directorate for Workforce Management located in Bethesda, Maryland.

B. GENERAL METHODOLOGY

1. End of Initial Obligation

A critical retention decision point for a service member is at the end of the initial obligation. The type of accession program used to enter military service affects the length of initial obligation. The minimum length of service is two years and normally applies only to those dentists categorized as direct commissions.

Any general dentist who stayed beyond four years of commissioned service was considered a "stayer." Because of the varying obligations, and since not all officers separate from the service exactly at the end of their requirement, this four year criterion covers all obligation periods from all accession sources, and provides some additional time to separate prior to being considered a "stayer." Any general dentist not completing four years of service was considered a "leaver."

C. PRELIMINARY ANALYSIS

The final data set consisted of 516 observations after applying the constraints mentioned above. Table 12 shows the number of observations by accession source in each active commission year cohort. Over all accession sources, 277 general dentists entered the Navy in 1998 and 1999, while only 239 entered in 2000 and 2001, a decline of 13.72 percent.

Table 12. Number of Dentists By Accession Source[96]

Accession Source	1998-1999 Cohort	2000-2001 Cohort	Total
Dental Student	39	24	63
Direct Commission	31	17	48
HSCP	84	56	140
HPSP	123	142	265
Total	277	239	516

[96] Table created by author utilizing general dentist information from BUMIS.

1. Description of General Dentists by Entry Cohort

Table 13 provides descriptive statistics for all the general dentists in the sample and by entry cohort. It offers insight into the characteristics of general dentists that will be used in the multivariate analysis.

Table 13. Characteristics of General Dentists[97]

Characteristic	1998-1999 Cohort N=277	2000-2001 N=239	Combined N=516
Accession Source (%)			
Dental Student	14.08	10.04	12.21
Direct Commission	11.19	7.11	9.30
HSCP	30.32	23.43	27.13
HPSP	44.40	59.41	51.36
Gender (%)			
Female	30.32	24.27	27.52
Male	69.68	75.73	72.48
Race (%)			
Asian or American Indian	11.55	16.32	13.76
Black	3.97	3.35	3.68
No Response / Didn't know	8.30	7.95	8.14
White	76.17	72.38	74.42
Age			
Under 30	79.06	79.08	79.07
Between 30 and 39	20.22	20.50	20.35
Over 40	.72	.42	.58
Retention (%)			
Stay	53.79	57.74	55.62

a. Accession Source

HPSP accessed more dentists than any other program, 51.36 percent of total accessions for the 1998 – 2001 period. HSCP accessed the second most dentists, accounting for 27.13 percent of total accessions during these four years. The direct commission program brought in the fewest dentists, representing only 9.30 percent of all

[97] Table created by author utilizing general dentist information from BUMIS.

accessed dentists in this time frame. A comparison of accession source distributions between the 1998-1999 and 2000-2001 cohorts shows that HPSP accessions increased in 2000-2001 while all other programs reflect a decrease in accessions.

b. Gender

Males represent 72.48 percent of the accessed general dentists for the 1998 – 2001 period. In the 2000 - 2001 cohort, males increased their representation over the previous cohort by nearly six percent to 75.73 percent.

c. Race

Whites represent 74.42 percent of the accessed general dentists for the 1998 – 2001 time-frames. Dentists identifying themselves as Asian or American Indian were grouped together and account for 13.76 percent of the dentists accessed in these four years. Only 3.68 percent of all the general dentists are identified as black. More than eight (8.14) percent of the total number of general dentists accessed did not respond to the race question or did not identify with the racial options.

Although racial distributions remained similar between cohorts, the percentage of Asians and American Indians increased in the 2000-2001 cohort by 4.77 percent, and White representation fell by 3.78 percent.

d. Age

Nearly 80 (79.07) percent of these officers are under the age of 30 at their active duty commissioning date in this four year period. Those officers between the age of 30 and 39 represent 20 percent in both cohorts. Officers over 40 years of age are less than one percent in both cohorts.

2. Continuation Rates for General Dentists

Table 14 reports the continuation rates of general dentists who were commissioned in these two periods of time. The 1998 – 1999 cohort shows a retention rate of 53.79 percent which is slightly lower than the 2000-2001 cohort which reports a

57.74 continuation rate. The overall continuation rate for Navy general dentists who were accessed between 1998 and 2001 is 55.62 percent.

Table 14. General Dentist Continuation Rates by Individual Characteristics and Entry Cohort[98]

Characteristics	**1998-1999 Cohort N = 277**	**2000-2001 Cohort N = 239**	**Combined N=516**
Accession Source (%)			
Dental Student	56.41	87.50	68.25
Direct Commission	80.65	64.71	75.00
HSCP	63.10	33.93	51.43
HPSP	39.84	61.27	51.32
Gender (%)			
Female	54.76	62.07	57.75
Male	53.37	56.35	54.81
Race (%)			
Asian or American Indian	59.38	58.97	59.15
Black	27.27	87.50	52.63
No Response / Didn't know	47.83	21.05	35.71
White	54.98	60.12	57.29
Age			
Under 30	52.97	55.03	53.92
Between 30 and 39	57.14	67.35	61.90
Over 40	50.00	100.00	66.67
Retention (%)			
Stay	53.79	57.74	55.62

a. Accession Source

With a retention rate of 75 percent, the direct commission program provided the highest continuation score of all accession sources during the 1998 – 2001 time period. The direct commissioning retention rate in 1998 – 1999 was 80.65 percent, but dropped to 64.71 percent in the following two years. HPSP had the lowest continuation rates during these four years; but, HPSP continuation rates increased by 21.43 percentage points from the first cohort to the next. A comparison of the two

[98] Table created by author utilizing general dentist information from BUMIS.

cohorts shows an increase in retention rates for HPSP and dental students and a decrease for direct commission and HSCP officers from the 1998 – 1999 to the 2000 – 2001 cohort.

b. Gender

Females had a slightly higher continuation rate, 57.75 percent, than males, 54.81 percent, for the period of 1998 – 2001. Both males and females showed increases in their retention rates from the 1998-1999 cohort to the 2000 – 2001 cohort. Males increased by 2.98 percentage points and females rose by 7.31 percentage points.

c. Race

The racial group categorized as Asian or American Indian had the highest continuation rate, 59.15 percent in this four year period of time. Overall continuation rates for Whites were 57.29 percent and Blacks were retained at 52.63 percent. During the 2000 – 2001 period, the Black retention rate was determined to be 87.50 percent, a 60.23 percentage point difference from the 1998 – 1999 cohort. White continuation rates also increased between the 1998 – 1999 and the 2000 – 2001 cohorts, but only by 5.14 percentage points.

d. Age

Dentists over 40 at the time of their active duty commissioning had the highest retention rate among all age groups, 66.67, during this four year period of time. Those officers who were commissioned under the age of 30 at the beginning of their active duty service had the lowest retention rate with 53.92 percent. Officers over 40 saw a 50 percentage point positive change in continuation rates between the 1998 – 1999 and 2000 – 2001 cohorts. Dentists between 30 and 39 at active duty entry had the highest retention rate in 1998 – 1999 with 57.14 percent opting to stay Navy. This rate increased to 67.35 in the next two years. Continuation rates for general dentists under 30 remained fairly stable between the two cohorts, showing a 2.06 percentage point increase in the 2000 – 2001 cohort over the 1998 – 1999 cohort.

D. ANALYTICAL METHOD

1. Theoretical Model

Multiple regression analysis allows for the estimation of retention models that consider several influencing factors. In logistic regression models, the dependent variable is always categorical. For the purpose of this research the binary dependent variable is stay, where stay equals 1 and leave equals 0. The theoretical model formula follows:

$$Li = \ln(Pi/1\text{-}Pi) = \alpha + \beta xi$$

where:

Li = log of odds ratio

Pi = Probability of continuation, given the personal attributes xi

α = Intercept parameter

β = Vector of slope parameters

xi = Vector of explanatory variables

2. Multivariate Logistic Regression Model

The theoretical model used to analyze the retention behavior of general dentists is shown below. Variable definitions are provided in Chapter IV.

a. General Dentist Model

The initial empirical model used to determine predicted probabilities for the continuation of General Dentists is:

$$\ln(Pi/1\text{-}Pi) = \beta_0 + \beta_1(FEMALE) + \beta_2(BLACK) + \beta_3(ASNAMIN) + \beta_4(NORESPO) + \beta_5(COM00\_01) + \beta_6(DIRECT) + \beta_7(HSCP) + \beta_8(DENT\_STU) + \beta_9(AGE3039) + \beta_{10}(AGE40PLUS)$$

where:

FEMALE = being female

BLACK = being African-American

ASNAMIN = being Asian or American Indian

NORESPO = unknown race or failed to answer

COM00_01 = being commissioned in 2000 or 2001

HSCP = being accessed through HSCP

DENT_STU = being accessed as a dental student

DIRECT = being accessed as a civilian dentist

AGE3039 = being 30 through 39 years old at time of commission

AGE40PLUS = being 40 or more years old at time of commission

IV. VARIABLE DEFINITIONS, HYPOTHESIZED EFFECTS AND MODEL RESULTS

A. DISCUSSION

This section of the thesis defines and discusses the explanatory variables used to analyze the retention of general dentists who face their initial retention decision. This section also states and justifies the expected effect of each independent variable on the dependent variable.

B. VARIABLE DEFINITIONS

1. Explanatory Variables

Demographics and accession sources are the two categories of explanatory variables used to evaluate the continuation behavior of general dentists who reach their first retention decision point. Table 15 shows the expected sign for each explanatory variable.

a. Gender (MALE, FEMALE)

The gender variable is binary and MALE serves as the base case. Although more females are becoming dentists than in the past, the Navy Dental Corps, like the Navy as a whole, remains dominated by males. Certainly, the integration of women on ships has provided more opportunities for women in the Navy. However, if shipboard life is viewed negatively by women, this will have a negative impact on a female's decision to remain in military service. Additionally, quality of life improvements and a better understanding of female needs has made the Navy a more hospitable place to work for women, yet, the nature of military life (i.e. family separation, unstable work hours, frequent duty station transfers, etc.) probably has a more

of a negative effect on females than males. Therefore, overall, being female is expected to negatively affect a woman's decision to continue in the Navy Dental Corps compared to a male dentist.

b. Race (WHITE, BLACK, ASNAMIN, NORESPO)

Race is described by four different categories: WHITE, BLACK, ASNAMIN, and NORESPO. WHITE serves as the base case since the Navy Dental Corps is predominantly white (74.32 percent). NORESPO was included in the model because of the large number of unknowns or no responses to queries about race. It is generally believed that minorities have more opportunities in military service than in the civilian workforce, due to the greater potential for racial discrimination in the civilian sector. As a result, the overall effect on retention of minority group membership is anticipated to be positive.

c. Age (UNDER30, AGE3039, AGE40PLUS)

Officers were separated into three age categories depending on age at time of commissioning. UNDER30 is the base case. Older individuals are likely to have more job experience (whether as a dentist or not) and probably appreciate the benefits and job security offered by the military. Therefore, age is anticipated to have an overall positive effect on retention decisions for officers who receive their commissions later in life.

d. Sources of Entry and Year

(1) Accession Sources (DENT_STU, DIRECT, HPSP, HSCP). As indicated earlier, there are multiple programs available for entry into the Navy Dental Corps. One would expect that those programs that offer the most financial support would have the highest continuation rates. HPSP, the most generous scholarship program, accesses the largest number of new dentists, and represents the base case. HSCP participating members receive the pay and benefits associated with active duty enlisted

service for up to 48 months, but must fund their school costs. Therefore, HSCP, as an accession source, is expected to have a negative effect when compared to the base case of HPSP.

Participants in non-scholarship programs such as direct commissions have other factors influencing their feelings towards the military and the likelihood of staying beyond their initial obligation besides money. For example, dentists who are direct appointments (DIRECT) probably have experience in the civilian workforce and may chose to enter the Navy because they were frustrated with the complicated reimbursement process and the responsibilities associated with a civilian dental practice. Compared to the base case (HPSP), DIRECT is presumed to have a positive effect on retention rates for general dentists.

DENT_STU are participants in a discontinued accession program. They were commissioned as Ensigns in the Inactive Reserves, but unlike HPSP participants received no pay or scholarship for tuition, books, or equipment. They were eligible for accession bonuses and the HPLRP to alleviate their education debt. They are likely to have little attachment or reason to bond with the military beyond the agreement to join the DC after graduation. Therefore, one can expect DENT_STU to have a negative effect on continuation rates for general dentists.

Dentists who entered under the FAP program were dropped from the analysis. There were too few observations in this data set for analysis, and all observations who were FAP participants were leavers.

(2) Commission Year (COM98_99, COM00_01). COM98_99 represents the base case for commissioning year. Officers commissioned in 2000 and 2001 are more likely to endure more frequent and longer deployments associated with the Global War on Terror, Operation Iraqi Freedom, and Operation Enduring Freedom. Therefore, it is likely that the commission year will have overall a negative effect on the retention decisions of officers commissioned in 2000 and 2001 compared to those commissioned in the earlier period.

Table 15. Explanatory Variables and Expected Signs[99]

Variable Name	Variable Type	Expected Sign
Demographic		
Gender		
MALE	Dichotomous	Base Case
FEMALE	Dichotomous	-
Race		
WHITE	Dichotomous	Base Case
BLACK	Dichotomous	+
ASNAMIN	Dichotomous	+
NORESPO	Dichotomous	
Age at Commission		
UNDER30	Dichotomous	Base Case
AGE3039	Dichotomous	+
AGE40PLUS	Dichotomous	+
Accession Source		
AFHPSP	Dichotomous	Base Case
DIRECT	Dichotomous	+
DENT_ STU	Dichotomous	+
HSCP	Dichotomous	-
Commission Year		
COM98_99	Dichotomous	Base Case

[99] Table reflects the author's perception of expected sign.

Variable Name	Variable Type	Expected Sign
Demographic		
COM00_01	Dichotomous	-

C. RESULTS

1. The Logistic Regression Model

Table 16 shows the results of the logistic regression model. The General Dentist model includes ten explanatory variables, five of which are significant in explaining retention behavior, utilizing a one-tailed test. The regression output shows officers commissioned in the 2000-2001 cohort (COM00_01) are 26.64 percent more likely to stay than the base case (COM98_99), significant at the .10 level. DIRECT and DENT_STUD are both significantly more likely to continue in the military at the .01 level than an HPSP participant. Those who did not list their race were found to be significantly less likely to continue military service at the .01 level than white dentists. However, those officers between the ages of 30 and 39 (AGE3039) when commissioned were more likely to continue with the Navy at the .10 level than the base case dentists who were under 30. Table 16 shows the coefficients and levels of significance for each explanatory variable.

Table 16. Logistic Regression Results for General Dentist Model (one –tailed test)

Variable	Parameter Estimate	Pr > Chisq
INTERCEPT	-.1232	.2461
COM00_01*	.2664	.0771
DIRECT***	1.2691	.0004
DENT_STUD***	.8576	.0029
HSPC	.0777	.7187
FEMALE	.1999	.1697
ASN_AMIN	-.0777	.3883
BLACK	-.5711	.2572
NORESPO***	-1.1433	.0007
AGE3039*	.3256	.0797
OVER40PLUS	.5079	.3482

Goodness of Fit Measures		
Log Likelihood Ratio (10 DF)	Chi-Square = 30.6846	< .0007
Generalized R-Square = .0577	Max-rescaled R-Square = .0773	

One-tail tests
*** Significant at .01 level
** Significant at .05 level
* Significant at .10 level

A model's goodness of fit can be measured using several methods. The predictive power of this model is low as evidenced by a generalized R-square of .0577 and a max-rescaled R-square is .0773 as shown in Table 16. This suggests that nearly 8 percent of the variation in the dependent variable is explained by the independent variables. Although these numbers are relatively low, one can expect lower R-square values with logistic regression models than with OLS models. However, and perhaps more importantly, the limited number of variables in this model also limits the level of the model's predictive power.

Another measure of goodness of fit, the Likelihood ratio, is significant at the .01 level. With this information, the null hypothesis that none of the explanatory variables has any effect on retention can be rejected (all βs equal 0) and it can be concluded that at least one coefficient (β) does not equal 0.

Table 17 shows a classification table for the model, a third method for measuring goodness of fit. Dividing the frequencies of STAYs by the number of observations totaled .5562, a value that falls between .540 and .560 probability levels. Choosing the .560 probability level, the classification table shows that this model correctly classifies 52.7 percent of the observations. The sensitivity results suggest that nearly 43 (42.9) percent of general dentists who opted to remain in military service were accurately classified. Conversely, a specificity of 65.1 represents the percentage of those dentists who were correctly categorized as leavers.

Table 17. Classification Table for General Dentist Model

	Correct		Incorrect			Percentages			
Prob Level	**Event**	**Non-Event**	**Event**	**Non-Event**	**Correct**	**Sensit-ivity**	**Specifi-city**	**False Pos**	**False Neg**
.560	123	149	80	164	52.7	42.9	65.1	39.4	52.4

2. Interpretation and Evaluation of Coefficients

Year of commissioning was a significant factor in an officer's decision to continue with military service. Dental Officers commissioned in 2000 through 2001 (COMM00_01) were determined to be more likely to stay in the Navy than those commissioned in 1998 through 1999. This could potentially be an increase in patriotism or call to duty after the events of September 11, 2001 which would have occurred early in their initial obligation period.

The FEMALE variable was determined to be positive but insignificant in the model, indicating that gender does not influence the retention behavior of general dentists. This may suggest that females share similar perceptions about Navy life as their male counterparts and therefore their retention decisions are not affected by their gender.

Surprisingly, race was not a significant factor in retention behavior. Although the variables BLACK and ASN_AMIN had negative estimated signs, the results were insignificant. This implies that minorities may hold the same feelings about opportunities in military service and the civilian sector as are held by those officers classified as white.

Interestingly, 42 of the 516 dentists did not list (or did not know) their race. The NORESPO variable proved to be negative and a statistically significant factor at the .01 level. It is difficult to explain this result, as there seems to be no reasonable basis on which to predict the retention behaviors of individuals simply because they fail to identify their race. However, it is interesting to note that 62 (61.9) percent of the NORESPO were male and nearly 79 percent were under the age of 30. This lack of racial identity may be a result of the officer's refusal to provide this particular information to the government or perhaps the officer could not relate to the limited racial choices offered.

Age at time of commission had mixed results. The results for AGE3039 were positive and statistically significant at the .10 level. Officers commissioned in this age range are more likely to continue Navy service beyond their initial obligation than Officers under 30, representing the base case. AGE3039 dentists are choosing more military dental experience over the opportunities offered by the civilian job market and lifestyle compared to younger dentists.

Dental Officers, who were 40 and over at time of commissioning, showed different results than their colleagues in the 30 through 39 age range. Compared to the base case the estimated results for OVER40PLUS were positive but insignificant. The negative effect is contrary to the expected sign. Although there were few dental officers in this category, the model suggests that they do not have a stronger affinity than officers commissioned less than 30 years of age to continue their Navy service beyond their initial obligation.

3. Significant Variables and Partial Effects

a. Notional Person

The notional person method shows the partial effects of an explanatory variable on the probability of exceeding the initial obligation. In the general dentist model all explanatory variables were dummy variables, and therefore were set to zero in specifying the notional or typical person. Table 15 identified the variables creating the notional person (base case). Each variable was then independently tested by changing the value of that variable to one. The partial effect of that variable on the probability of continuation was determined by comparing the resulting probability of continuation with that of the base case, the notional person. Table 18 illustrates the partial effects for the general dentist model.

Table 18. Partial Effects for the General Dentist Model

Variable	Partial Effect
COM00_01*	.06651
FEMALE	.04993
DENT_STU***	.20653
DIRECT***	.28952
HSCP	.01939
ASN_AMIN	-.01929
BLACK	-.13616
NO_RESPO***	-.24937
AGE3039*	.08118
AGE40PLUS	.12576

One-tail tests
*** Significant Variable at .01
** Significant Variable at .05
* Significant Variable at .10

Based on these results, an officer commissioned in 2000 or 2001 was 6.65 percentage points more likely to stay beyond his or her initial commitment than an officer commissioned in 1998 - 1999. An individual who is exactly the same as the base case except for being accessed as a dental student, is 20.65 percentage points more likely to remain in the Navy beyond the first obligation than an HPSP accessed dentist; a direct accession would be nearly 29 percentage points more likely to be retained than a general dentist who entered through HPSP. Those commissioned between their 30th and 39th birthday have a continuation rate 8.12 percentage points higher than the notional person, who was under 30 at time of commissioning. It is interesting to note that those who match the base case except that they did not provide race information, are almost 25 (24.94) percentage points less likely to continue their military career than a white officer.

4. Potential Problems with the Model

Perhaps the most striking issue with this model is the low R-square value, which is primarily a result of the limited number of variables in the model. This would suggest that a degree of omitted variable bias exists. Fewer independent variables reduce a model's ability to explain dependent variable variation, and ultimately, negatively affect the model's predictive capabilities. However, the model retains its ability to describe and

identify characteristics that have significant effects on the continuation of officers in the Navy Dental Corps facing their initial obligation decision.

Multicollinearity exists when several of the explanatory variables are highly correlated. The problem with multicollinearity is that it inflates the variances of the coefficients of variables and may cause inaccurate signs and inconsistent coefficients. To check for multicollinearity, variable inflation factors (VIFs) were calculated for each explanatory variable in the model. Because the model has a low R-square, the best method to test for multicollinearity is to compare the model's VIF with that of each independent variable.

The comparable OLS model's VIF is determined by the following formula: $1/(1-R^2)$, and the general dentist model has a VIF of 1.0602. Only DIRECT and DENT_STU variables have VIFs greater than the model's VIF, and the difference between the model and the variables are negligible. A comparison among independent variables does not reveal any outstanding correlations. Therefore, this evaluation suggests that multicollinearity is not an issue for this model.

V. AN AUCTION BASED RETENTION BONUS FOR THE DENTAL CORPS

A. OVERVIEW

Facing shortages in the Lieutenant Commander ranks as reported in CNA studies, and with only 55 percent of the general dentists opting to continue military service, a retention bonus could potentially resolve these manpower issues. Chapters 3 and 4 evaluated the retention characteristics of Navy general dentists, but unfortunately, the evaluation was not capable of determining the affects of monetary compensation because of the standard pay scale covering military members. Yet, Navy Dental Corps 2004-2005 exit survey results show that pay was the most identified reason for dentists choosing to leave military service.[100] A CNP Quick Poll reported the top three factors to "greatly increase or increase desire to stay" involved money.[101] More specifically, 86 percent of respondents admitted that a retention bonus would influence their intentions to remain in the Navy.

Utilizing results from the American Dental Association's (ADA) 2005 Salary Survey, this chapter discusses the opportunity costs of Navy general dentists, as measured by compensation, and applies an auction type retention bonus to provide an informed illustrative model of potential retention behaviors at an initial stay / leave decision point.[102]

[100] CAPT Phil Rinaudo, Dental Corps Planner, email to author 10 January 2007.

[101] Carol Newell, Kimberly Whittam, & Zannette Uriell, "CNP Quick Poll, Medical Communities: Dental Corps, Medical Corps, Medical Service Corps, and Nurse Corps," 6 June 2005.

[102] Compensation is defined as all pay and eligible bonuses. Non-pecuniary benefits are not considered.

B. COMPENSATION FOR GENERAL DENTISTS

1. Civilian Compensation

According to the ADA, nearly 90 percent of all dentists are identified as independent dentists. The average annual salary for all independent general practitioners was $185,940 in 2004.[103] For all general dentists with less than five years of experience and who responded to the survey, the mean annual salary was $147,480.[104] These dentists match approximately the level of experience a Navy general dentist would have, should that officer decide not to continue with military service after completing his initial obligation.

Given the mean annual salary and the standard deviation, one can graphically describe the cumulative annual salaries for civilian general dentists, assuming salaries follow a normal distribution.[105] Figure 2 provides this illustration, where the X-axis represents the standard deviations from the mean and the Y-axis represents compensation in thousands of dollars.

[103] The American Dental Association, Survey Center, The 2005 Survey of Dental Practice: Income from the Private Practice of Dentistry, (Chicago, IL), January 2007, 7.

[104] Ibid., 13.

[105] The standard deviation was $68,320 with a sample size of 30 participants.

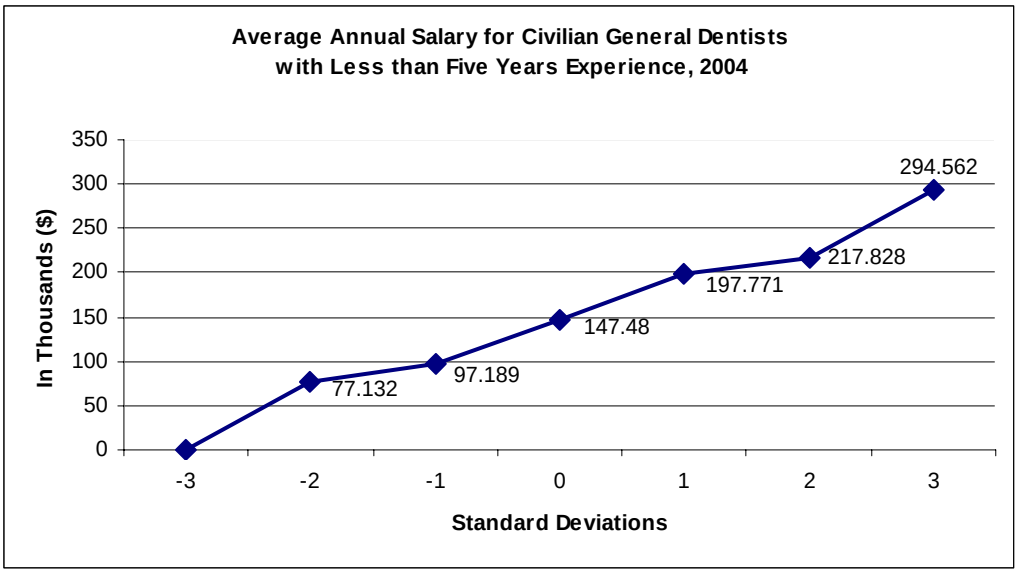

Figure 2. Cumulative Distribution of Average Annual Civilian General Dentist Salary With Less Than Five Years Experience, 2004[106]

2. Military Compensation

Based on the assumptions used for the earlier regression analysis, this thesis assumes a general dentist will face his first continuation decision at the fourth year of active duty service. Table 18 shows the calculated annual pay for this officer as $79,253, including housing and subsistence entitlements plus ASP and VSP.[107]

Table 19. Annual Salary for Navy General Dentist with Fours of Active Duty Service[108]

Pay Source	Annual Amount ($)
Base Pay	52,704
Basic Allowance for Subsistence	2,313
Basic Allowance for Housing	11,236
Additional Specialty Pay	6,000
Variable Specialty Pay	7,000
Total	79,253

[106] Figure created by author utilizing the mean annual salary and standard deviation provided by the ADA Survey Center, 2005 Survey of Dental Practice: Income from the Private Practice of Dentistry, January 2007.

[107] A dentist opting to take either a one or five year contract would have at least a 12 month obligation, and therefore, remains eligible for these bonus programs.

[108] Author created table and determined amounts with 2007 Military Pay Scale and Fiscal Year 2007 Dental Officer Specialty Pay Plan.

3. Opportunity Cost

By choosing to remain a uniformed dentist, Navy DC Officers opt for compensation lower than what is available in the civilian market. For the purpose of this thesis, opportunity costs are defined solely by the monetary difference between civilian and military general dentists. The true opportunity costs would be represented by bids submitted by each dentist. In reality, there are other opportunity costs besides money, such as family separation, quality of life factors, etc., but salary differences are the easiest and most convenient to quantify. Moreover, studies and polls suggest that money is a primary consideration when dentists are deciding to stay or leave active military service.

The difference between the annual salary levels depicted in Figure 2 and the actual military pay is an opportunity cost. In a theoretical cohort of 130 dentists facing the completion of their obligation period, the mean opportunity cost is approximately $68,000 per year. Figure 3 illustrates these compensation differences, where the X-axis represents the number Navy dentists at their retention decision point. The Y-axis describes the dollar difference between the two compensation levels.

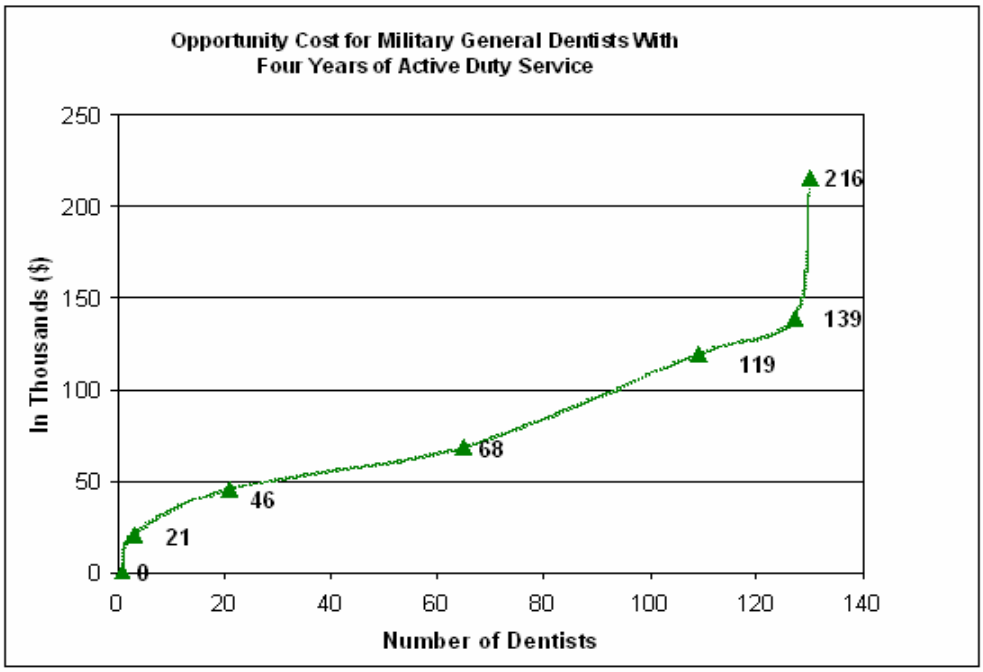

Figure 3. Opportunity Cost for Military General Dentists With Four Years of Active Duty Service

C. PROPOSED BONUS STRUCTURE

1. The Assumptions

There are several assumptions with this retention bonus program. First, a Navy Officer participating in the auction sells his service for multiple years and/or for one-year, respectively. In exchange the Navy guarantees an annual fixed bonus plus employment for that specific period of time. For the purpose of this thesis, the multiple year option is for a period of five years. A one-year option is valid for only one year of bonus and employment.

Retention bonus levels are determined through two consecutive auctions. In the first auction, bids are accepted from dentists who wish to sell their services for a one year employment contract with the Navy. These results establish an opportunity cost line. Winning bids are identified and asked to participate in a second auction that determines the bonus level for a five-year employment contract.

The second assumption is that bidders in the second price auction will always bid truthfully since because their bid does not determine the bonus they are paid, only whether or not they are eligible to receive the bonus. There is no advantage to the bidder to overbid his services. In fact, a bid too high simply removes the seller from consideration for either the one or a five-year employment contract and bonus.

The third assumption is that a more risk-averse officer will bid a lower price for his services in a five-year contract, and consequently, increase the savings for the Navy. Those who have a high tolerance for risk may select the one year bonus. However, a dentist who selects a one-year option at the end of his initial obligation period is no longer eligible for the five-year option. With no guarantees regarding future one year bonuses, the Officer who selects this option is willing to accept a higher degree of uncertainty.

The one-year option allows the Navy a quick and flexible force shaping tool to ensure that its immediate operational needs are met. The one-year option can be utilized to capture those dentists who are, in economic terms, considered to be "on the margin."

These dentists probably do not have a strong affinity for military life, and do not intend to make the Navy a career. Perhaps they are enticed by higher salaries in the civilian market or the infrequent family separation. However, given the appropriate incentive they would be willing to complete another year on active duty.

Of course, this one-year option is always based on the needs of the Navy and offers more uncertainty for the dentist. If a sufficient number of dentists exist, then the one-year option would not be available. In this circumstance, a dentist completing his initial obligation would need to decide to accept the five-year employment contract with bonus, continue active duty service without a bonus, or face separation from active duty.

For better planning purposes the Navy may decide to lock in a high percentage of five-year contracts. Theoretically, this would reduce the number of one-year contracts needed and simultaneously reduce costs over a single year. However, at the onset of this program a large number of five-year contracts may increase short-term costs. As the force is shaped and manned appropriately, these costs will be reduced.

2. The Actors

This proposed auction based retention bonus model reverses the roles of seller and buyer as described in the current Navy bonus system. In this program, the dentists are the sellers and the Navy is the buyer. General dentists are selling their professional services to the Navy in exchange for guaranteed employment for a specific period of time and an annual bonus.

With multiple sellers (Navy DC Officers) and only one buyer (the Navy), the reverse auction is the most appropriate auction type. Each seller has a personal value assigned to the service he offers. He knows what level of compensation he wants in exchange for his services. The Officer is aware of the opportunity costs and what he is giving up in exchange for continued service in the military. The Dental Officer informs the Navy of this price, and then, the Navy must decide if the price is acceptable.

Because Navy dentists are located globally, a sealed bid auction is the most efficient and effective method of delivering the desired price. This could be done via a

web-site or email to a specific office that would consolidate and organize the bids. After reviewing the bids, the Navy buys the services at the first excluded bid and pays that bonus level to all participating dentists.

3. Economic Surplus

An auction based retention bonus model has the potential to recover economic profits given to sellers in a traditional bonus program. Current Navy practice is to determine a bonus level and pay everyone that same bonus without understanding the opportunity costs of the professionals they seek to incentivize. This type of bonus is designed to capture those professionals at the margin and then pay everyone that amount. Consequently, with a traditional bonus there are professionals whose payment greatly exceeds their opportunity costs, resulting in a positive economic surplus for the seller (Navy DC Officers) through an income transfer from the buyer (Navy). Figure 4 illustrates the seller's surplus in a traditional bonus program, where the X-axis represents the number of dentists and the Y-axis represents the bonus amount in thousands of dollars. The area with the slanted lines is what the Navy must pay the dentists in this type of bonus. The dotted area is the excess the economic rent paid to those receiving the bonus.

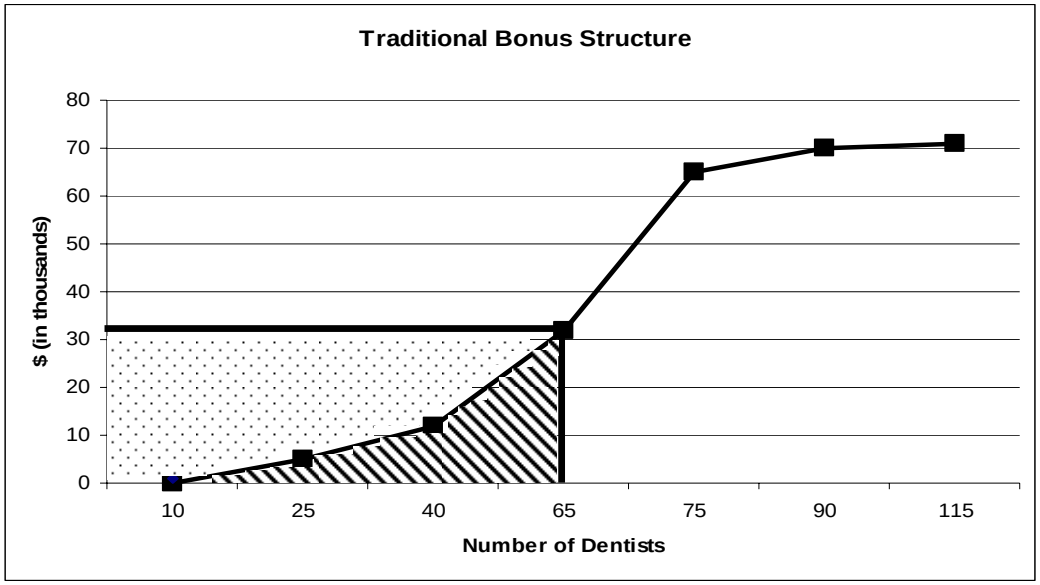

Figure 4. Traditional Navy Bonus Structure

An auction helps to find the bonus level based on a retention target, the desired number of professionals sought to be retained. Initially, bids are accepted from dentists selling their services to the Navy for a one-year employment agreement. These bids determine the actual opportunity costs. If the auction stopped here, the surplus issue would remain much like that of the traditional method. All sellers would receive the same bonus amount. Figure 5 illustrates the seller's surplus in the first auction, where the X-axis represents the number of dentists and the Y-axis represents the bonus amount in thousands of dollars. The dotted area is the surplus economic rent paid to the seller (Navy Dentists) in excess of their theoretical opportunity costs.

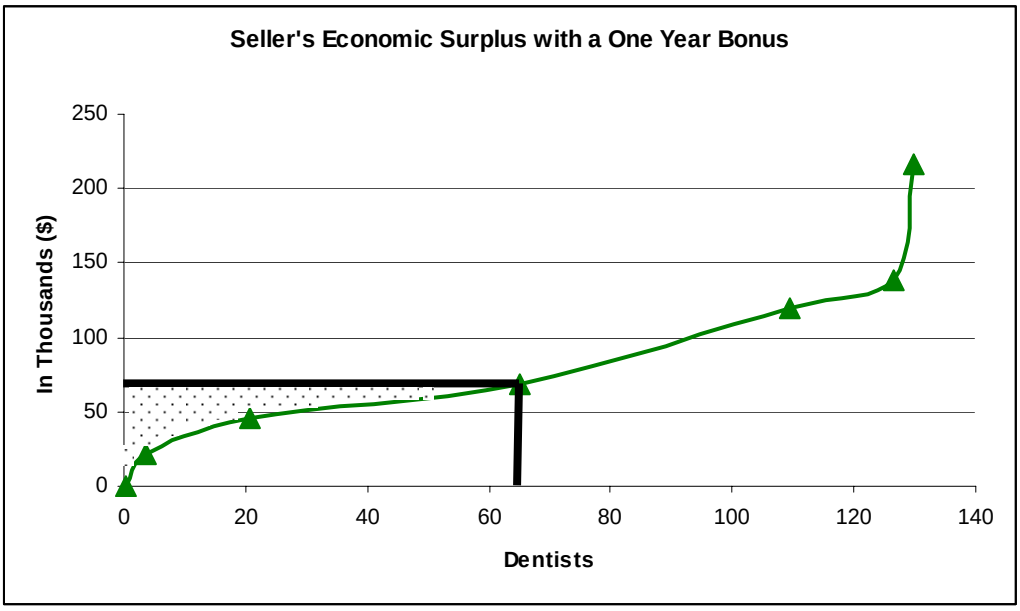

Figure 5. Economic Surplus for a One-Year Auction Based Bonus

In this proposal, one-year contract winning bidders are then asked to submit a second bid, asking for the price of their services in exchange for a five-year employment agreement with the Navy. Here, the Navy will be able to recover some of the lost economic surplus, because the second auction brings the bonus level closer to the true opportunity costs of these professionals.

The five year contract is designed to attract those dentists who are more risk averse and/or those who have a strong affinity for military life. Figure 6 illustrates the seller's surplus in the second auction, where the X-axis represents the number of dentists and the Y-axis represents the bonus amount in thousands of dollars. The dotted area is the excess economic rent paid to the seller (Navy Dentists) who opted for a five year contract. The black and white diamond area represents the savings to the Navy. The solid shaded area illustrates the economic surplus paid to those dentists whose one year bids were accepted.

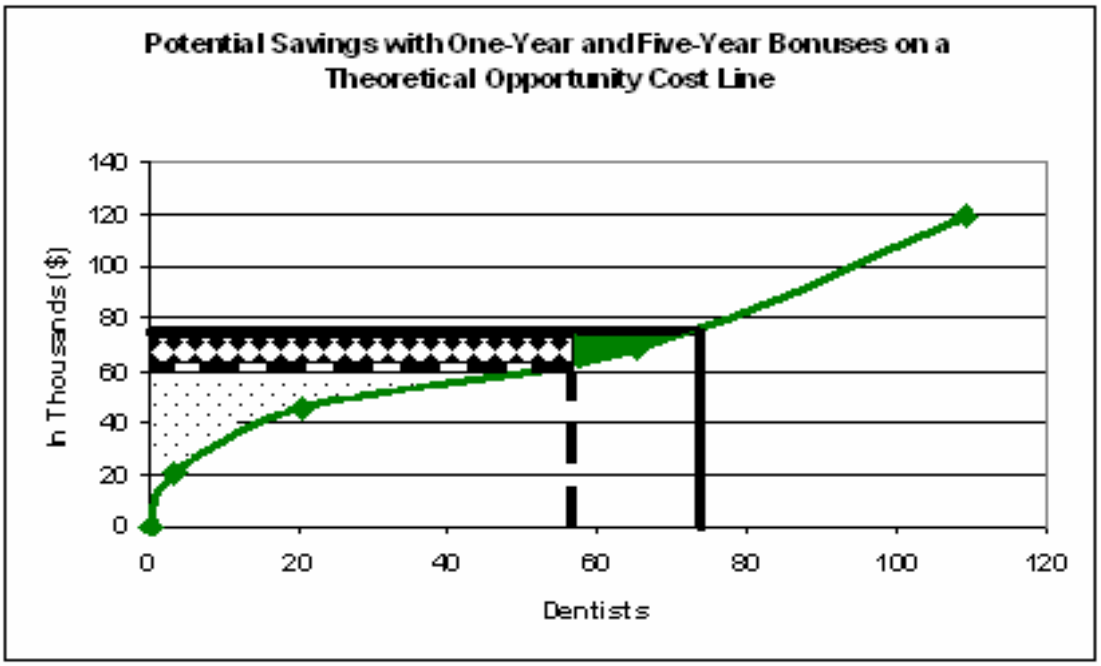

Figure 6. Potential Savings and Economic Rents Paid to Winning Bidders

4. The Formula

This bonus program operates on a fundamental break-even economic formula. The formula is: $M = A(1-p^T) / T(1-p) + B[1-(1-p^T) / T(1-p)]$

where:

M = the multi-year annual payment (certainty equivalent)

T = the time period in years

A = the amount of the one-year bonus

B = the opportunity cost (civilian pay)

p = the probability that a one-year bonus is offered each year

The benefit of this formula is that it allows the Navy to select a cost priority. For example, the Navy may choose to minimize one-year contract costs, which would mean that the Navy would be relying more on long term contracts to supply its dental professionals rather than buying the services of dentists for a single year. Conversely, the Navy could choose to minimize long term contract costs and instead focus on retaining medical professionals for only one year beyond the initial obligation. This flexibility is an advantage over the current bonus structure in terms of force shaping.

5. The Formula Applied

Without experimental or actual survey data, the best this thesis can provide is a theoretical application of an auction based retention bonus. Economic experiments, in conjunction with other theses, are currently in progress, but results are not available for discussion or application at this time.

For the purpose of this thesis, the theoretical cohort of general dentists facing the completion of their initial obligation is 130. Suppose the Navy seeks to retain 78 general dentists, the formula can determine the five-year bonus level necessary to appropriately incentivize 78 dentists to contract with the Navy. For this example, the Navy seeks a manning plan that guarantees a higher retention of five-year contract personnel and will accept 20 one-year contracts.

In the next step, the Navy calls for bids for a one-year contract and determines the one-year bonus level to be $70,000, based on a reverse 2nd price sealed bid auction. Then, the question is to identify the value of M, the annual bonus level for these five-year contract dentists. The variable T is five years. In this theoretical example, the Navy desires a low number of one-year contracts, so the probability for the one-year contract, A, is placed at .15, represented by the variable p. If one assumes the opportunity cost to be the annual civilian general dental salaries as reported by the ADA, then B equals

approximately $69,000. The annual retention bonus (M) for general dentists would be $69,170. The annual compensation for a Navy general dentist would then be $149,253.

Of course, should the Navy desire to lower the multi-year bonus, this retention bonus structure provides the Navy a flexible force option, the ability to offer more single year employment contracts and bonus options. For instance, if one assumes the Navy seeks 40 5-year contracts instead of 58 as in the previous example and the opportunity cost is $57,000, then the multi-year bonus would be reduced to $58,842 per year. Naturally, the number of single year bonuses would increase accordingly to 38.

Table 20 shows the pay sources and annual amounts for a general dentist utilizing these examples.

Table 20. Annual Salary for Navy General Dentist with Four Years of Active Duty Service Plus a One-Year or Five-Year Retention Bonus[109]

Pay Source	**One-Year Agreement** **Annual Amount ($)**	**Five-Year Higher Guaranteed Retention** **Annual Amount ($)**	**Five-Year Flexible Force Agreement** **Annual Amount ($)**
Base Pay	52,704	52,704	52,704
Basic Allowance for Subsistence	2,313	2,313	2,313
Basic Allowance for Housing	11,236	11,236	11,236
Additional Specialty Pay	6,000	6,000	6,000
Variable Specialty Pay	7,000	7,000	7,000
Retention Bonus	70,000	69,170	58,842
Total	149,253	148,423	138,095

The one-year and higher guaranteed options reveal that the theoretical annual salary of a Navy would exceed the current mean compensation for civilian general dentists with comparable years. This is not surprising. This illustration assumes the

[109]Author created table and determined amounts with 2007 Military Pay Scale and Fiscal Year 2007 Dental Officer Specialty Pay Plan.

mean opportunity cost for a Navy dentist is based on the mean civilian compensation. If the Navy chooses to retain more than 50 percent of its dentists then it must pay more than the mean civilian salary in this example. Actual bids will reflect the sellers' consideration of other factors affecting their opportunity costs such as quality of life, civilian liability insurance, et cetera.

However, even with an "exaggerated" opportunity cost, the auction based retention bonus still distributes less money than a traditional bonus program. With the proposed traditional method, the Navy would pay nearly $5.460 million to general dentists annually. Utilizing an auction based bonus, the Navy would spend $52,000 less annually but provide higher levels of retention for general dentists. The greatest savings comes from a more flexible force option which lowers the multi-year bonus level but requires more one year contracts. This option saves approximately $450,000 annually. Table 21 compares the costs of a traditional and auction based bonus programs.

Table 21. Cost Comparison Between a Traditional and Auction Based Bonus

Criteria	**Traditional**	**Higher Retention**		**Force Flexible Option**	
		One-Year Option	Five-Year Option	One-Year Option	Five-Year
Dentists Wanted	78	20	58	38	40
Bonus Level	$70,000	$70,000	$69,107	$70,000	$58,842
Sub-total	$5,460,000	$1,400,000	4,008,206	$2,660,000	$2,353,680
Total Savings	**-**	**$51,794 (1.0 %)**		**$446,320 (8.2%)**	

Again, one could expect potential savings to be greater provided actual opportunity costs are less than what was used in this model.

VI. CONCLUSION AND RECOMMENDATIONS

A. CONCLUSION

Retention studies provide a valuable service to policy makers because they are capable of identifying factors that significantly impact an individual's decision to continue active duty service. With this information, manpower policy makers can create or adjust programs, policies, and procedures to meet the immediate and long term needs of the Navy.

This thesis, utilizing BUMIS data, identifies some key characteristics of Navy general dentists and their retention behavior. The research focused on accession sources and personal demographics for 516 general dentists, commissioned between 1998 and 2001. Results from a logistic regression estimated general dentists, who entered the Navy through Direct Commissioning and the Dental Student programs, were 29 and 20 percent respectively more likely to continue beyond their initial obligation compared to those officers accessed through HPSP. However, these programs have not been as successful as HPSP in recruiting dentists, as nearly 60 percent of Navy general dentists are accessed through HPSP. Dentists commissioned between the ages of 30 and 39 are more likely to continue service beyond their initial obligation than younger dentists. Race and gender were determined not to significantly affect retention decisions.

With a Navy active duty continuation rate of only 55 percent, general dentists are being drawn away from military service. Multiple studies support this conclusion. Subsequently, this low retention figure has created a significant shortage of Lieutenant Commanders and left many billets unfilled in the Navy Dental Corps. Designed correctly, the retention bonus can be a flexible tool to assist personnel planners in controlling and predicting manning levels while simultaneously incentivizing the appropriate number of dentists to stay Navy and continue military service.

Beyond the logistic regression, this research explored the impact of an auction based retention bonus for general dentists to counter the attraction of the civilian sector.

The mathematical foundation for the auction based retention bonus is a break-even formula. In order to determine the bonus level for a multi-year bonus, the formula requires inputs such as opportunity costs, the length of the multi-year bonus, the probability of a one-year contract, and the value of the one year contract. The difference between average military pay and civilian general dentist salaries represented opportunity costs. In this model, the theoretical opportunity cost was calculated to be $69,000. Further, for the purpose of this thesis, the Navy sought to retain 78 out of 130 dentists with 58 agreeing to stay for an additional five years (40 in the flexible force option), the length of the multi-year contract. Therefore, the model assumed a low probability of a one-year bonus (.15).

The model predicted the Navy could buy the services of 58 (40 in the flexible force option) general dentists at the end of their initial obligation for five years with a $69,000 ($57,000 in the flexible force option) annual bonus. An additional 20 (38 in the flexible force option) dentists would agree to an additional year for $70,000. Although these numbers seem extreme, their high values are not a surprise, as the only opportunity cost examined in this illustrative model was compensation. Actual bids from Navy general dentists will reflect true opportunity costs, and are anticipated to be lower than in this theoretical model.

B. RECOMMENDATIONS

The Navy Dental Corps should focus its recruiting efforts on those accession programs whose participants are more likely to stay Navy. Based on this research the Navy should therefore target direct commissions (the Dental Student program was terminated). Unfortunately, direct commissions today are extremely challenging to recruit as demonstrated by the inability to meet single digit recruiting goals. Of course, this also may be a consequence of recruiting efforts aimed at participants for HPSP and HSCP which have higher recruiting goals. In either case, the Navy Dental Corps needs to work to retain its professionals. Although this seems obvious, it is worth mentioning, because retention becomes vitally important when overall recruiting goals are not being achieved.

Although there are multiple possible solutions to address retention, for the Navy general dentist, a retention bonus seems to be an obvious remedy. An auction based retention bonus, as demonstrated in this work, determines bonus levels closer to a general dentist's true opportunity costs and hence could potentially save significant funds to be used in other areas. Further study in this area is warranted, especially live auction experiments.

As this research was ending, NAVADMIN 053/07 announced the Navy Dental Corps Critical Skills Retention Bonus (DC CSRB) for qualified general dentists. DC CSRB offers general dentists with three to eight years of active commissioned service $40,000 for two years, provided they have not been selected for, started, or completed residency or advanced clinical training,. The DC CSRB may be renewed consecutively up to the eighth year for an obligation to end at the 10^{th} year of active military service.

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LIST OF REFERENCES

American Dental Association, *The 2005 Survey of Dental Graduates.* Chicago: The American Dental Association Survey Center, September 2006.

American Dental Association, *The 2005 Survey of Dental Practice: Income from the Private Practice of Dentistry.* Chicago: The American Dental Association Survey Center, January 2007.

Brannman, S., Almendarez, M., Rattelman, C., and Scherer, E., *Health Professions' Retention-Accession Incentives Study Report to Congress (Phase 1: Compensation Comparison of Selected Uniformed and Private-Sector Health Care Professionals).* Washington, DC: Center for Naval Analysis, October 2002.

Bristol, R., *Effect of Increased Operational Tempo (Post 9/11) on the Retention of Navy Medical Corps Officers*. Master's Thesis, Naval Postgraduate School, Monterey, CA, March 2006.

Bureau of Medicine and Surgery Webpage. http://navymedicine.med.navy.mil/default.cfm?selTab=bumed&ecmid=93E9008D-802E-D019-ABBA-0925B2764081; accessed January 2007.

Bureau of Medicine and Surgery Webpage. *Dental Corps History*. http://navalmedicine.med.navy.mil/default.cfm?seltab=about&selmod=7AF9F11-2A5E-780B-45D6C0D83FF101C8&docid=10307&parentid=942CA57C-802E-D019-A46C463C916A02DC; accessed January 2007.

Bureau of Medicine and Surgery Webpage. *Fiscal Year 2007 Dental Officer Special Pay Plan,* http://navymedicine.med.navy.mil/default.cfm?selTab=bumed&ecmid=93E9008D-802E-D019-ABBA-0925B2764081&docid10766; accessed January 2007.

Campbell, D., *Incentives: Motivation and the Economics of Information.* New York: Cambridge University Press, 2006.

Chief of Naval Operations Instruction 1110.1A, Administration *of Health Professions Accession Programs (HPAP)*, dated 2 February 2007.

Christian, A. B., *Influences on the Retention of Residency-Trained and Non-Residency Trained Navy Dental Corps Officers,* Naval Postgraduate School, Monterey, CA, March 2004.

Department of Defense. *Financial Management Regulation Military Pay Policy and Procedures-Active Duty and Reserve Pay*, Volume 7A, Chapter 6, March 2005.

Filip, W., *Improving the Navy's Officer Bonus Program Effectiveness.* Master Thesis, Naval Postgraduate School, Monterey, CA, June 2006.

Gates, W., *Innovations in Special Pay and Bonuses.* Presented at Western Economic Association, San Diego, CA, 30 June 2006.

Homb, H., *Salary Auctions and Matching as Incentives for Recruiting to Positions that are Hard to Fill in the Norwegian Armed Forces,* Naval Postgraduate School, Monterey, CA, December 2006.

Houser, R., CDR, MSC, USN, Re: Accession Goals and Achievement. Available email: kurt.houser@navy.mil, 14 December 2006.

Klemperer, P., "Auction Theory: A Guide to the Literature." *Journal of Economic Surveys, v. 13, p.* 229, Summer 1999.

McAfee, R. P. and McMillan, J., "Auctions and Bidding." *Journal of Economic Literature,* v. 25, pp. 701-707, Summer 1987.

Newell, C., Whittam, K., and Uriell, Z., *CNP Quick Poll, Medical Communities: Dental Corps, Medical Corps, Medical Service Corps, and Nurse Corps*, Navy Personnel, Research, Studies, & Technology (PERS-1), 6 June 2005.

Rinaudo, P., CAPT, DC, USN, Re: Dental Corps Exit Polls. 10 January 2007.

Stacey, R., Navy *Dental Corps Contract or Uniform: Study of Factors Influencing Business Case Analyses,* Master's Thesis, Naval Postgraduate School, Monterey, CA, March 2006.

Telephone conversation between Worm, D., CAPT, DC, USN, General Dentist Specialty Leader and author, 22 December 2006.

United States Navy Department. *Manual of the Medical Department (NAVMED P-117),* Washington, DC, 1996.

Woolfolk, R., LCDR, MSC, USN, Dental *Corps One Page World Book*, 15 July 2006. CD-ROM. (Washington, DC).

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